Carl H. Eigenmann

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PARASITIC BACTERIA AND THEIR RELATION TO SAPROPHYTES.[1]

BY THEOBALD SMITH.

PARASITES, whether they be animal or vegetable, have certain characters in common which are due to their relation to their host rather than to their own intrinsic organization. I shall endeavor to point out a few of those which may be observed among bacteria parasitic on animals. Since they usually give rise to well-defined diseases, they are also called pathogenic bacteria, or more popularly, disease-germs. Almost all pathogenic forms may be considered true parasites, at the same time all truly parasitic forms have been found pathogenic.

There are certain external regions of the animal body quite uniformly the seat of specific bacteria. They are the skin and alimentary canal. Observations have shown that in the different sections of the digestive tract different bacteria are found. To some of these a digestive function has been attributed, the power of peptonizing albumens, and thus facilitating their absorption. The bacteria inhabiting the mouth are numerous, and some are found quite constantly, such as the well-known *Leptothrix buccalis*. A microcobe has also been found which some years ago was erroneously regarded as identical with the cholera bacillus. The mistake was pointed out by demonstrating its inability to grow upon gelatine, which the cholera germ readily does. I have repeatedly found in my own saliva the same liquefying coccus

[1] Read before the Biological Society of Washington, D. C., December 11, 1886.

greatly preponderating over other species, although months elapsed between consecutive examinations.

Such bacteria cannot be considered strictly parasitic. It is true that they have adapted themselves to conditions which are now necessary to the continued existence of many of them, yet, if we draw the line at which saprophytic phenomena end and parasitic begin, they are not true parasites. For they do not invade the living tissues to meet the resistance which the living cells interpose, but live upon dead organic matter present upon the skin, in the mouth, and the digestive tract in general.

This adaptation to certain media is common to many micro-organisms. The juice of the grape becomes the habitat of a saccharomyces (*Cerevisæ*) which converts the glucose into alcohol and carbonic dioxide. When this fermentation has ceased the bacterium aceti oxidizes the alcohol into acetic acid. When the medium is too acid the bacterium aceti cannot exercise its fermenting power, and another saccharomyces (*Mycoderma*) first reduces the acidity of the liquid by oxidation. Examples may be multiplied in illustration of this fact that bacteria as well as fungi select certain media as most favorable to their growth.

It now and then occurs that bacteria not strictly parasitic may prove pathogenic in setting up fermentations and decompositions in the alimentary canal. The substances thereby produced are absorbed, and act as chemical poisons. It seems very probable that our information of digestive derangements will be made more precise and better methods of relief applied when more attention has been bestowed upon the bacteriology of the digestive tract. Under certain conditions the *Leptothrix buccalis*, the most common microbe in the mouth, may become in a sense parasitic. When the enamel of the teeth has been removed by acids formed in the mouth during the fermentation of food, this microbe causes the slow disintegration known as caries by invading the dentinal tubules and the pulp-cavity. Now and then bacteria which carry on a harmless existence in one place may become very virulent in others. A few years ago Dr. Sternberg found that rabbits died within a few days after the injection beneath the skin of some of his saliva. This virulence may last for years. For it is extremely difficult to dislodge a microbe from a place which it finds conducive to its vital activity. Harmless in the human mouth, it is able to multiply in the body of one

of the higher mammals, to act as a true parasite and destroy life. This may explain the occasionally poisonous bites of animals. The sputum in pneumonia has been found equally fatal to rabbits. But here we are confronted with the important but still unsettled question whether the pathogenic microbe in the sputum is not the cause of the pneumonia.

Whether we shall ever find bacteria within the organs, in the blood and lymph-channels of the animal body, as permanent parasites which do no appreciable injury, is very improbable. Many experiments which have been made lead to the conclusion that the animal organism in health is free from bacteria. This is an almost daily experience in the laboratory. Even the excretions, such as urine and milk, are free from bacterial life. Moreover, if there were harmless parasitic forms present, why should we always obtain the same microbe alone from organs affected with the same disease? That bacteria do occasionally penetrate into the closed cavities from the mucous surfaces need not be disputed, but they are quickly destroyed. Large numbers injected directly into the blood have been found greatly reduced in a few hours, and entirely absent after twenty-four hours. To impress this fact more firmly we may picture to ourselves our skin and the entire alimentary canal in contact with myriads of these organisms. A delicate mucous membrane is all that separates them from the vital organs. Yet not a single individual is capable of gaining a permanent foothold within this membrane. This applies only to non-parasitic species, however.

In contrast with this lasting enmity between bacteria and the healthy tissues is the more friendly relation between animal parasites and the latter. Trichinæ and tape-worm cysts enjoy an undisputed repose in the muscular tissue of their host. Some entozoa live in the connective tissue, others infest the blood; they have even been found within the blood-corpuscles of fishes and turtles of apparently normal vitality.

A survey of the various biological properties of those bacteria which have been more carefully studied up to the present does not reveal to us two extreme classes,—those that are capable of a parasitic existence only on the one hand, and those that can only live upon dead organic matter. We actually find bacteria possessing the vicarious power of living, now a parasitic, now a saprophytic existence. The microbes which occasion such dis-

eases as anthrax, typhoid, glanders, cholera, etc., multiply readily in organic infusions in milk, even in drinking-water, for a variable period of time. They grow luxuriantly upon the cut surface of a boiled potato, which is a purely vegetable product. Bacteria of this kind are without doubt closely related to the numberless forms living in the soil and water, and drifted about, in a dried state, with currents of air. Yet they differ in some physiological function, some chemical power, which enables one group to destroy animal life, while the other is itself destroyed as soon as it enters the animal body. There are other parasitic bacteria which are much more fastidious in their choice of a subsistence outside of the body, which shun the boiled potato and require conditions approximating those found in the animal organism. The bacillus of tuberculosis flourishes only on blood-serum at the temperature of the body, and the gonococcus, according to Bumm, seems to prefer human blood to that of the lower animals.

Finally, there are parasitic forms only known to us from a microscopic examination of the tissues which they infest, such as the microbe of leprosy, and perhaps of syphilis. Cultivation upon nutrient substances has not yet succeeded. We must therefore infer that these forms have become so thoroughly adapted to a life in the tissues of the living body that the conditions there prevailing cannot be realized sufficiently in artificial culture to induce multiplication.

These facts explain why many pathogenic bacteria can be cultivated,—grown at will in tubes containing appropriate media; we simply make use of their capacity for living and multiplying upon dead matter, a capacity ancestral in its origin, and suggesting that all pathogenic bacteria were derived by a process of natural selection from the innumerable harmless species everywhere peopling the air, the soil, and the water. How the parasitic nature of these bodies was acquired gives ample scope for speculation, as nothing definite is known. To me it seems most reasonable to suppose that many of the bacteria now known to cause disease acquired certain physiological properties in their natural habitat, possibly in warm climates, which properties accidentally fitted them to live as parasites of the animal organism. These having once been brought together, a new disease, a new scourge was added to the inheritance of animal life. The para-

site being subject to all the contingencies which affect other forms of life in nature, it may ingraft itself more and more upon the system, or it may die out in the course of time.

While assuming, without any infringement of known biological laws, that all parasitic bacteria were derived from saprophytic forms, the difference between them is so sharply defined as to make us stand in awe at the tremendous power of the one class when contrasted with the other. Millions of saprophytic bacteria may be introduced under the skin or into the blood-vessels of animals without any marked disturbance. A single pathogenic microbe, by rapid multiplication within the body, may destroy life in a day. The power thus acquired by these minutest and simplest of living organisms is one of fearful effect upon the most highly organized class of animals. It is a war of pigmies against giants, which ends with the destruction of either or both opponents. If the giant be only a rabbit, it is at least a billion times larger than each microbian opponent. If we take the larger animals or man, the relation in size between the microbe and its victim differs but little from that of the earth and the meteorite falling upon its surface.

The derivation of pathogenic from harmless saprophytes is well suggested by three organisms,—those causing Asiatic cholera and typhoid in man and so-called cholera among swine. These organisms thrive very well upon various media, indicating that they are not necessarily limited to the living body as a habitat. But the remarkable feature which they have in common is their power of spontaneous movement in liquids. During their parasitic life this function does not appear to be of any service whatever. The bacteria of cholera are restricted to the small intestine, where they multiply with enormous rapidity. Those of the other diseases mentioned are not limited to the intestines, but may be found growing in the blood-vessels of various organs in the form of dense colonies or plugs. The motility must be regarded as a feature of their saprophytic life which they would lose if a strictly parasitic habit were finally adopted. An illustration of a somewhat different nature is furnished by the *Anthrax bacillus*, the first disease-germ thoroughly studied, which produces such a rapidly fatal malady in many of the domesticated animals and in man. According to Koch, it is an inhabitant of certain low, marshy regions, where it goes through its cycle of growth without enter-

ing the animal body. In fact, it cannot complete this cycle within the body, for that most important stage—spore formation—only takes place on exposure to the air, so that bacilli within the dead body, if immediately buried, do not form spores. These facts illustrate clearly the preponderance of a saprophytic life in this very virulent organism.

To indicate graphically the probable phylogenesis of parasitic bacteria, Hüppe has constructed the following table, according to De Bary:

True Saprophytes.

1. Ferment bacteria.	2. Pigment bacteria.	3. Parasitic bacteria.
Aerobiotic.		Facultative parasites.
Agents of oxidization fermentations.	Facultative anaerobiotic.	Facultative saprophytes.
	Obligatory anaerobiotic.	Obligatory parasites.

The term facultative parasites signifies that the bacteria included in the class are capable of living as parasites or of passing through certain stages of their development as parasites. Facultative saprophytes are such parasites which may live as saprophytes either during the whole or a part of their life-cycle.

If for a moment we look more carefully at the parasitic life of bacteria, a number of interesting facts and problems appear. First of all each microbe produces definitely characterized symptoms and lesions which are grouped together as a specific disease. According to the abode which the microbes choose in the animal body, these symptoms and lesions will vary within wide limits. Some species multiply within the capillary system of the various organs, some are confined to the lymphatics, while others produce suppuration in the connective tissue by attracting an army of leucocytes to oppose them. A few are constantly found within leucocytes themselves. Some bacterial diseases are limited to special organs or tissues. It may be the lungs or the spleen, the skin or the mucous membrane of the intestine which becomes the seat of attack, and to which the disease remains restricted. In the various situations minor modifications in disposition and grouping give rise to diseases of quite different character. Bacteria growing in dense plugs in the capillaries produce in-

juries and changes different from those which arise when they are loosely scattered.

It is a curious fact that those bacteria which are strictly parasitic and which have not yet been cultivated in nutritive media, or only with considerable difficulty, cause diseases which are very slow in their progress, often lasting for years and frequently checked and cured. Tuberculosis, syphilis, and leprosy are illustrations of this fact. On the other hand, the diseases which are produced by bacteria that thrive in artificial media are usually quite rapid in their course. The conflict in the latter case is much fiercer and more quickly decided. In other words, the bacteria are more virulent. The better adapted the parasite becomes, the more compatible will it be with the host and the less capable of carrying on an independent existence. It is for the interest of the more strictly parasitic forms that their host live as long as possible. This is not necessarily so with those species whose life in nature may continue more or less independent of a parasitic existence.

The more perfect parasitic bacteria, manifesting their presence in very slowly progressive maladies, usually reside within the protoplasm of the cells, where the feeble irritation leads to a hypertrophy and then to a gradual destruction of the cell itself. The bacteria are probably taken up in the same way in which the amœba takes in solid particles. The cell endeavors to destroy them in this way, but their persistence within the cell-protoplasm indicates that the struggle has resulted in the victory of the parasite, which even finds the battle-ground a convenient place of abode. There are one or two rapid diseases, such as mouse septicæmia, in which this intra-cellular habitat of the microbes is always observed.

Another interesting feature which they share with entozoa is their limitation to certain species of animals. Some are peculiar to one species, others may thrive upon several. This susceptibility of certain animals to definite pathogenic germs is so constant a phenomenon that it has now become an indispensable means in the diagnosis and differentiation of bacteria, and in conducting investigations upon obscure points in the life-history which are of direct practical value. In other words, the smaller animals are to the pathologist what chemical reagents are to the chemist.

I have already stated that there are many entozoa, inhabiting the tissues of their host, which do but little harm, and which may measure their parasitic existence by years, while a few, such as *Trichina spiralis*, are now and then fatal. Corresponding with these gradations in destructive effect there are similar gradations of virulence among bacteria. Some produce only local disturbances; they are speedily destroyed and eliminated. Among these are the microbes causing suppuration. Others destroy organs and tissues very gradually, and are indirectly fatal by exhausting the vital energies or breaking down some organ necessary functionally to the processes of life. Among these may be mentioned more particularly the tubercle bacillus. Still others may cause death from within a few hours to weeks after their invasion. These include the microbes of septicæmia, cholera, typhoid fever. In general, however, the tendency of bacterial parasites is eminently destructive. The chemical poisons formed during their growth irritate and finally destroy the animal cell. If we pass from a consideration of the biology of these micro-organisms to the diseases of which they are the cause, a broad field of interesting facts lies before us, as instructive and suggestive to the biologist and the student of nature as to the pathologist and the practical physician. I can, however, merely glean a few facts which may serve to illustrate the relation of epidemics to the life-history of bacteria.

There is a certain group of diseases called miasmatic, because the poison seems to come from the air and the soil. With the light shed upon this subject in recent years, the micro-organisms, presumably the cause, live in the soil as their natural habitat. This class would include all strictly endemic diseases, since they cannot be carried at will to localities free from them. The cause, residing in the soil, must have certain conditions necessary to its life, and unless these are found in new localities the disease will not take root. Though malaria is reaching out into new territory, we have never yet heard of a quarantine against its progress.

Another group includes maladies only transmitted from one subject to another. They are strictly contagious diseases, corresponding to the strictly parasitic bacteria, which cannot multiply outside of the animal body.

A third group, intermediate between these extremes, possesses, in a way, the characteristics of both. The micro-organisms may

live both as parasites and saprophytes; and being capable of multiplying wherever the proper pabulum exists, the possibility of rapid diffusion, and hence of great epidemics, is readily conceivable. It is believed by some that for most of such germs a sojourn in the soil is a necessary preparation for the parasitic stage. Pettenkofer regards cholera and typhoid not contagious, but insists that the germs must first undergo some unknown changes in the soil before they again become capable of inducing disease. Hence the spread of epidemics depends as much upon certain external conditions as upon the presence of the agents themselves. This is controverted ground, however, and most authorities to-day are inclined to consider the air, the soil, and water as simple vehicles for the spread of disease.

There still remain many obscure problems concerning the movement of epidemics, but their solution does not seem so far away, as a very firm foundation has been laid for future observations. This has been constructed from the life-history of micro-organisms. The application of the principles and fundamental facts of biology to the elucidation of the causes of disease and its prevention is once more brilliantly vindicated. Disease is no longer the mysterious, personified entity of the past. It has been brought within the domain of laws which govern all life upon the earth.

ON SOME POPULAR ERRORS IN REGARD TO THE ESKIMOS.

BY JOHN MURDOCH.

ONE is often surprised, on taking up a popular treatise on anthropology, to find the number of erroneous beliefs concerning a race of people about whom so much has been written as about the Eskimos, which have been quoted by author after author without question, until they have come to be accepted by the world of readers as matters of established fact. Most of these errors are due to the fact that many of the earlier authors, even when themselves explorers who correctly recorded the facts they observed, hastily accepted the conclusion that isolated peculiarities were characteristic of the race as a whole, as if, for

instance, the race of Englishmen should be described from the study of the inhabitants of a single county. Then the compilers, who had no means of ascertaining the correctness of the statements they had to work with, have perpetuated the beliefs. Even so acute an observer as Sir John Richardson has fallen into the error, in his "Polar Regions," of supposing that the peculiarities of manners and customs, correctly observed by him in certain limited areas, were universally practised throughout the whole extent of country inhabited by the Eskimos.

Certain authors of the present day, however, are not less to be blamed for this habit of hasty generalization.

In a manual of anthropology of the most recent date,[1] which might be supposed to contain the latest results of anthropological research, since one of the authors is a professor and the other an assistant professor in the "École d'Anthropologie" at Paris, in the midst of a concise characterization of the Eskimo race, remarkably correct, on the whole, for a compilation, is the statement, "polyandry is practised,"—"on pratique la polyandrie" (p. 537). The natural inference from this is that such a practice is general, or, at least, not uncommon, among the Eskimos.

Now, if one takes the pains to search through the original sources of information in regard to the Eskimos, as the writer has of late had the opportunity of doing to a great extent, it will be found that while sexual morality is everywhere, as a rule, at a low ebb among them, and polygamy is frequently mentioned, cases of polyandry, where a woman has two or more regular husbands, are very rarely referred to. In fact, the statement above quoted is probably based on the cases mentioned by Bancroft in his "Native Races of the Pacific States."

Bancroft states that in former times in the island of Kadiak, two husbands, a principal and a secondary one, or sort of *cicisbeo*, were allowed to one woman, but quotes no authority for this statement (vol. i. p. 82). Again, he refers to Seemann ("Voyage of the 'Herald,' vol. ii. p. 66), who says, speaking of the western Eskimos, "Two men sometimes marry the same woman." Seemann's acquaintance with the Eskimos, however, was only such as could be obtained in visits to Kotzebue Sound, in three successive summers, when the natives came on board the ship

[1] Précis d'Anthropologie, par Abel Hovelacque et Georges Hervé. Paris, 1887.

as she lay at anchor, and the people from the vessel occasionally visited the shore. I know from experience the difficulty of obtaining accurate information under such circumstances.

The statement, therefore, is not free from suspicion, especially as Seemann follows it up with another at variance with the experience of later explorers in the same region, and, indeed, of those who have been brought in contact with the Eskimos in most other places,—namely, that "after the marriage ceremony has been performed infidelity is very rare" (*ibid.*).

These instances stand almost alone. The only other case where anything of the kind is to be found is in Graah's "Narrative of an Expedition to the East Coast of Greenland," where he says, "report [among the West Greenlanders] said that the inhabitants of the East Coast were accustomed, when visited by scarcity, to destroy their women, so that the sex was usually at a premium among them, every woman having two or three husbands" (p. 78). He, however, makes no mention of finding any such cases among the East Greenlanders when he visited them, but, on the contrary, speaks of one man with two and another with three wives, which indicates anything but a scarcity of women.

On the same page of Hovelacque and Hervé's book it is stated, "Les Eskimaux habitent, selon la saison, des tentes de peaux ou des trous creusés en terre." "Holes dug in the earth" seems, to say the least, an exaggeration to one who has ever entered one of the comfortable and neatly-built wooden houses of the northwestern Eskimos, though these are covered by a mound of turf, or one of the extensive structures described by Captain Graah, who gives the most detailed description of the Greenlander's house ("Narrative," etc., pp. 45 and 46), sometimes sixty feet long, accommodating seven or eight families, with "regular walls, from six to eight feet high, built of earth and stones," roofed with beams covered with sticks and turf.

In fact, as far as I can discover from consulting a very large number of original authorities, the Eskimo winter-house is never more than partially underground, and in some cases even somewhat elevated above the surface of the earth, while throughout the great middle region, from Hudson's Bay northward among the archipelagos, the winter-house is generally of snow, built up, on the frozen ground. It is indeed surprising that anything so

well known as these snow-houses should be passed by unmentioned by the authors of the "Précis d'Anthropologie."

In spite of all authorities, however, the belief appears to be very wide-spread that the Eskimo passes the long cold winter night—the darkness of which, by the way, is very much exaggerated in regard to most of the region inhabited by the Eskimos, considering that the extreme northern point of the American continent extends but little beyond latitude 71°—in a sort of hibernation in underground dens, living in enforced idleness and supporting life by stores of meat laid up in less inclement seasons.

As Bancroft puts it, "About the middle of October commences the long night of winter . . . and humanity huddles in subterranean dens; . . . in March the dozing Eskimo rubs his eyes and crawls forth" ("Native Races," i. pp. 43, 44); and again, "In midwinter, while the land is enveloped in darkness, the Eskimo dozes torpidly in his den" (p. 55).

But in reality the experience of all explorers shows that the Eskimo does nothing of the kind. If he did, he would soon perish from starvation, for improvidence is one of his greatest characteristics, and very little is done in the way of storing up supplies for the winter. To be sure, they do not live the same out-door life as in the continuous daylight of summer, but their winter-life is as far removed as possible from idleness or hibernation.

A sketch of the winter avocations of the Eskimos of Point Barrow, who came under my personal observation for two winters, will serve to illustrate the truth of this statement. Point Barrow lies in latitude 71° 16′ north, and consequently there are seventy-two days—from the middle of November to the latter part of January—when the sun does not appear above the horizon, though there is sufficient twilight from ten o'clock in the morning to three in the afternoon to enable one to work out-doors.

The sea is frozen over and the land covered with snow, but the seals have made their breathing-holes in the new ice, and are to be caught with the spear, while nets may be set surrounding cracks where they resort for air. Every fine day, and even some stormy ones, large numbers of men are scouring the ice in search of seals and bears, while others are busy at home with carpenter-work, often carried on in the open air, in spite of the cold.

The village by no means presents an appearance of torpidity. The children are playing out-doors, or going out with the dog-sleds along the beach for a load of fire-wood; parties are travelling back and forth between the adjacent villages, and even the old men who can no longer lounge round the assembly-house, because it is not heated, except on great occasions, are out in groups gossiping on the knolls, wrapped in their cloaks. At this season, too, visitors come from distant villages, and the great dances and semi-dramatic festivals are held.

With the "dark of the moon," late in December, comes the season for catching seals in the nets set along the rifts in the ice-field. Now the men stay out all night, night after night, in the coldest weather, and reap the great seal harvest of the year, a single man sometimes capturing as many as thirty in one night.

After the great seal-netting is over seals are still to be netted in small numbers, and hardly a day passes that the men who have stayed in the village are not out in greater or less numbers tending their nets, while all the women and children are busy catching little fish through holes in the ice. Meanwhile, the richer or more energetic families have started off with the first gleam of the returning sun for the hunting-grounds, three or four days inland, where they remain camped in snow-huts, hunting reindeer and catching white-fish through the ice of the rivers, till the approach of spring warns them to return for the whale-fishing. Thus the winter, in spite of the extreme inclemency of the climate, is passed in one continued round of activity.

Hovelacque and Hervé, however, are much more correct in regard to a point concerning which popular belief is most persistently at fault. If there is one article of popular faith regarding the Eskimos that passes unquestioned, it is that they are very small, if not actually dwarfish in stature. Our authors state that the pure-blooded Eskimos are of medium or small stature, according to the classification of Topinard, medium stature being 1.65 m. (about 5 feet 4 inches), and small stature, 1.60 m. (about 5 feet 1½ inches) and less. They believe that 1.62 m. (about 5 feet 3 inches) is the average for male Eskimos unmixed with Danish or Indian blood. (It is probable, however, that there exist few, if any, Eskimos whose blood is mixed with that of the Indians, since, till within a few years, Indians and Eskimos, where they came in contact, have been on terms of the deadliest hatred.)

Let us compare with this statement the measurements given by those who have actually observed the Eskimos.

All who have written about the western Eskimos agree that they are, if anything, above the middle height (see the authorities quoted by Bancroft). And this has been insisted upon as a point of difference between them and those of the east. This difference, however, does not hold good. Oldmixon's figures ("Report U. S. International Polar Expedition to Point Barrow," p. 50) show that the average height of males at Point Barrow (5 feet 3 inches) falls a little short of Topinard's "taille moyenne," while Parry gives 5 feet 5½ inches for the average of males at Igloolik ("Second Voyage," p. 492), and Schwatka states that the Eskimos of King William's Land are above the Caucasian race in stature, speaking of individuals 6 feet, or even 6 feet 6 inches, in height (*Science*, iv. p. 543). Parry, again, speaks of the men of Baffin Land, whom he met on his first voyage, as from 5 feet 4½ inches to 5 feet 6 inches in height; and another early explorer, Lieutenant Chappell, speaking of the natives of the north shore of Hudson's Strait, says, "The males are, generally speaking, between five feet five inches and five feet eight inches high" ("Voyage to Hudson's Bay, 1817," p. 59). According to Petitot ("Monographie des Esquimaux Tchigtit," p. xii.), "Les grands Esquimaux des bouches du Mackenzie et de l'Anderson sont d'une taille plutôt au-dessus qu'au-dessous de la moyenne. Il est parmi eux des hommes fort grands."

I can find but one series of measurements that at all corroborate the popular opinion of the small size of the Eskimos, and these are those taken by Dr. Sutherland at Cumberland Gulf. Here the average height of twenty-three adult males was found to be 5 feet 2.4 inches ("Journal Ethnological Society," iv. p. 213). Even this is above Topinard's standard of "petite taille."

Hovelacque and Hervé believe that the greater heights reported are due to admixtures of foreign blood, but it is worthy of notice that Schwatka's "giants" were found among a people who are far distant from any Indians, and have had little or no intercourse with the whites, and that most of the taller men at Point Barrow are of an age that precludes the possibility of their being the descendants of white men. Petitot expressly states (in the work referred to above), "On ne trouve chez eux [the Mackenzie Eskimos] de métis." On the other hand, the

small race measured by Sutherland come from a region where they have been long in contact with the whites.

The evidence, therefore, seems strongly to contradict the popular belief. It is not unlikely that the popular idea arose from the fact that the earlier explorers compared the Eskimos with some of the tallest of the European race.

I am strongly inclined to believe that the very name by which we know these people owes its origin to a similar case of hasty generalization. "Eskimo," according to the best authorities, means "eater of raw flesh," and most people believe that all Eskimos habitually eat their food raw, devouring enormous quantities of reeking flesh and blubber.

Undoubtedly flesh is sometimes eaten raw, especially in a frozen state, and in certain limited regions where fuel is very scarce, raw-flesh eating appears from necessity to have become a habit, as, for instance, at Cumberland Gulf (*teste* Kumlien, "Bulletin U. S. National Museum," No. 15, p. 20).

Nevertheless, most observations indicate that this habit is exceptional, and the writings of all the original observers, from the time of Egede and Crantz, are full of accounts of the cooking of food, even when the oil-lamps furnished the only fire for this purpose.

Captain Parry explicitly states that the people of Igloolik preferred to boil their food when they could obtain fuel ("Second Voyage," p. 505), and we, also, found that food was habitually cooked at Point Barrow, though certain articles, like the "black skin" of the whale, were usually eaten raw.

The enormous consumption of fat, supposed to be a physiological necessity to enable them to withstand the excessive cold, is probably the exception rather than the rule, to judge from the accounts of actual observers. It seems quite probable that the amount consumed in most cases is little, if any, greater than that eaten by civilized nations, when we consider that the people who eat the fat of the seal with the flesh and use oil for a sauce to their dried salmon, have no butter, cream, fat bacon, olive oil, or lard.

We found, indeed, at Point Barrow, that comparatively little actual blubber either of the seal or whale was eaten, though the fat of birds and the reindeer was freely partaken of. Seal or whale blubber was too valuable,—for burning in the lamps, oiling leather, and many other purposes, especially for trade.

Neither does the general belief that they drink train-oil appear to be supported by reliable evidence, and some authors in various localities especially deny it.

I trust that I have presented sufficient evidence to show that the popular picture of the dwarfish Eskimo, dozing in an underground den, keeping up his internal heat by enormous meals of raw blubber washed down with draughts of lamp-oil, is based on exaggeration, to say the least, rather than on actual facts.

THE SIGNIFICANCE OF SEX.

BY JULIUS NELSON.

EXPLANATION OF PLATES I—IV.

The figures have been selected to show as great a variety as possible, that the unity which can be discovered may be a generalization of value. For the sake of clearness they have been drawn with as little elaborateness as possible, and to that extent are diagrammatic.

The following abbreviations have been used:

Z. w. Z.—Zeitschrift für wissenschaftliche Zoologie.
M. J.—Morphologisches Jahrbuch.
Carnoy.—La Biologie Cellulaire, 1884.
Bütschli.—" Protozoa," in Bronn's Classen und Ordnungen des Thierreichs.
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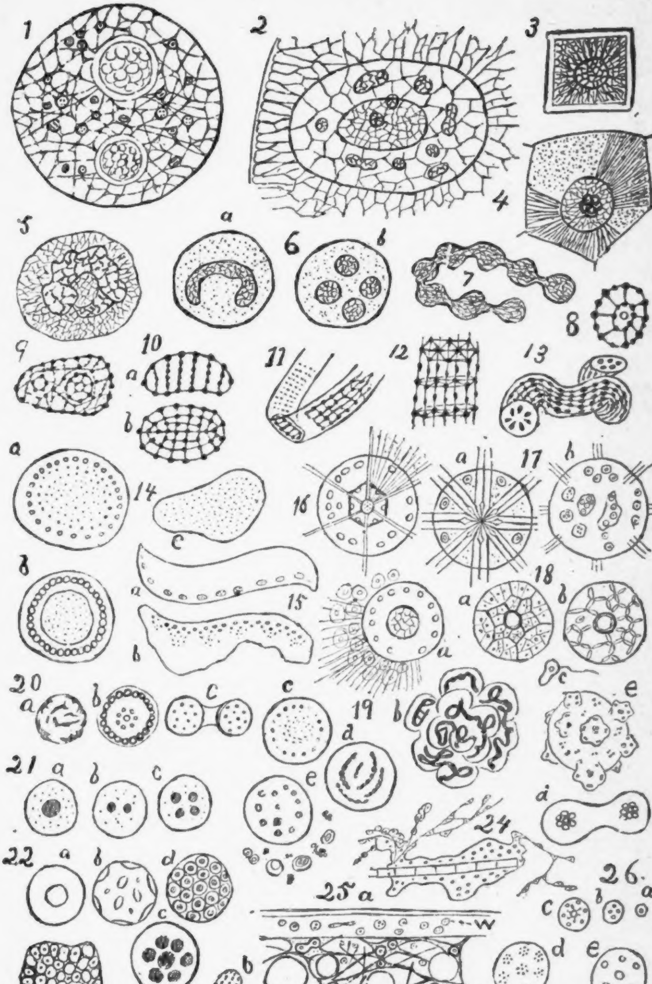
PLATE I.

FIG. 1. *Actinosphærium eichornii*—Gruber,[1] Z. w. Z., xxxviii.—The protoplasm is in the form of a net-work with enlarged nodes, many of which bear nuclei in various stages of karyokinesis.

FIG. 2. *Calcarina spengleri*—Bütschli, M. J., xi.—A nucleus surrounded by reticulated protoplasm is shown. It contains one large and several small nucleoli, all

[1] The name following the species refers to the author of the paper from which the figure was copied, and does not necessarily refer to the discoverer of the species.

PLATE I.



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having essentially the same reticulate structure. Some of the nucleoli are dividing by simple constriction.

FIG. 3. *Intestinal epithelium cell* of an *insect*—Carnoy, p. 190.—The reticulate nucleus is slung by a fine net-work, whose radial trabeculæ are the more pronounced; they branch towards the periphery of the cell.

FIG. 4. *Intestinal epithelium* from an insect larva—Carnoy, p. 195.—The granules in the cytoplasm have been indicated in some sectors, and the reticulum in others. The heavy nuclear reticulum, containing the chromatin, has contracted under the action of the *chrom-aceto-osmic* mixture of Flemming, and reveals a fine reticulum of achromatic protoplasm otherwise obscured by the presence of the chromatic reticulum (or filament, as the case may be).

FIG. 5. *Giant-cell* from marrow of rabbit—Carnoy, p. 262.

FIG. 6. *Encysted Vorticella*—Carnoy, p. 261.—In *b* the nucleus has divided into four.

FIG. 7. Nucleus of *Stentor polymorphus*—Carnoy, p. 260.

FIG. 8. Nucleus of *Monas vivipara*—Bütschli.—Microsomata of various sizes are united by processes so as to form a regular net-work.

FIG. 9. Nucleus of *Ceratium tripos*—Bütschli.—One of the nucleoli has an internal reticulum; the other is vesicular, having only a *surface* reticulum.

FIG. 10. Nucleus of *Ceratium tripos*—Bütschli.—No nucleoli present. *a* is an optic section from the side, *b* is a view of the ventral surface. The microsomata are strung in a row on each of the dorso-ventral filaments.

FIG. 11. Tentacle of *Noctiluca miliaris*—Bütschli.

FIG. 12. Diagram illustrating the structure of striped muscle—Melland, Q. J. M. S., xxv.

See also 93, *d*—Van Beneden, A. B., iv.—Contraction and amœboid movement accompanied, perhaps caused, by mutual attraction of the microsomata.

FIG. 13. Nuclein filament from a gland-cell of an insect—Carnoy, p. 233.—The chromatic microsomata are arranged in a reticulum imbedded in the surface of the *hyaloplasm filament* (nucleolus).

FIG. 14, *a*. A nucleus of *Amœba proteus*—Gruber, Z. w. Z., xli.—The chromatin granules are largest peripherally. In *b* (Z. w. Z., xl.) there is a differentiation of a large central nucleolus with fine granules from a surface membrane of large, closely united microsomata. At times the microsomata are reduced to so fine granules that only a diffuse staining results.

FIG. 14, *c*. *Chœnia teres*—Gruber, Z. w. Z., xl.—The chromatin granules have grown from invisible points.

FIG. 15. *Trachelocerca phœnicopterus*—Gruber, Z. w. Z., xl.—Like Fig. 14, this cell (rhizopod) is multinucleate. In *a* nucleoli appear in each nucleus; in *b* the nuclei have broken down to the state of free microsomata that divide up finer and finer.

FIG. 16. *Haliomma erinaceus*—Bütschli, after Hertwig.—The central capsule only is shown, with its large central nucleus and peripheral smaller nuclei budded from the central one, which has itself peripheral "nucleoli" that resemble the small "nuclei."

FIG. 17. Central capsule of *Acanthometra*. *a*, Bütschli, after Hertwig; *b*, after Stein.—In *b* the nucleoli have become independent bodies, and ar[illegible] irregular division of the nucleus into individual nuclei, probably f[illegible] purposes.

FIG. 18. Central capsule of *Collozoum inerme*—Bütschli, after He[illegible]

the nucleoli are getting clothed with a definitely bounded plasma. In *b* these new cells or germs have become elongate and arranged in a reticulum like that of Hydrodictyon; later they become free and are expelled as flagellate monads, as at *c*. *d* is a young capsule dividing; the nucleus consists of a group of nucleoli or microsomata. *e* is an older capsule budding.

FIG. 19, *a–b*. Central capsule of *Thalassicolla pelagica*—Bütschli, after Haeckel. *b* shows the nucleus budding; it now has its chromatin in a filament which here and there preserves its reticulate arrangement seen in *a*.

FIG. 19, *c–e*. Capsule of *Th. nucleata*—Bütschli, from Hertwig, etc.—In *c* the chromatin is in a surface layer of microsomata and a central granular mass. In *d* the microsomata are in the form of beaded filaments. In *e* the capsule contains many small nuclei dividing, and outside are similar groups that have probably migrated from the capsule.

FIG. 20, *a*. Nucleus from *Amœba lucida* (multinucleate)—Gruber, Z.. w. Z. xli.—The "membrane" bounding the nucleoplasm is at a distance outside of that in which the chromatin bodies lie. These have irregular processes in *a*, indicating the presence of a reticulum. In *e* the nucleus is dividing; the two daughters are still connected by a bridge of hyaloplasm like that which is seen in Figs. 41, 42, etc.

FIG. 21, *a–c*. Nucleus of *A. prima*—Gruber, Z. w. Z., xli.

FIG. 22, *a–d*. Nucleus of *Euglypha alveolata*—Gruber, Z. w. Z., xl.—*a* shows a central nucleolus, *b* many peripheral ones. In *c* they are massed near the centre; in *d* they have multiplied so as to fill the nucleus, and each has taken on itself a structure similar to *a*. This reminds us of the "germinal balls" of Stein and others.

FIG. 23. Nucleus of *Ceratium tripos*—Stein, filled with germs that are set free to reproduce the mother.

FIG. 24. *Labyrinthula*—Cieukowski, A. m. A., iii. (see Lankester, "Protozoa," Encyc. Brit.).—The plasma in which the simple nucleolus-like bodies live, move, and divide is in the act of digesting a conferva filament.

FIG. 25. A section near the surface of *Sphærozoum neapolitana*—Bütschli, after Haeckel.—A layer of "yellow cells" (symbiotic) lies on the surface. The body is formed of spherical vacuoles, "needles," and a "syncytium" of nucleated plasma masses, united by processes with one another. Compare Fig. 1, also volvox, a reticulum of nerve-cells, and Figs. 8–10, etc. The physiological reason for this structure is probably alike in these various cases. *b* shows a nucleus dividing, the nodes of its reticulum appear as granules. Homogeneous nuclei dividing are often amœboid.

FIG. 26, *a–h*. A nucleus of *Pelomyxa villosa*—Greeff, A. m. A., x.—*a* has one nucleolus. In *c* there are several, one central, and a peripheral set. In *d* each has split up into a group of granules or small microsomata; in *e* these have again united, and in each nucleolus repeats the structure of *a*, and is set free as *g*. *h* is a "refringent corpuscle," formed from *g* by disappearance of the nucleolus.

PLATE II.

FIG. 27, *a–e*. Nucleus of *Klossia octopiana*—Schneider, A. Z. E. G., 2d ser., i.—*a* shows a complex nucleolus budding off smaller nucleoli, which in *c* ultimately become nucleolated; *d* shows nuclei dividing; *e* shows a cyst where the remains of the old nucleus is surrounded by the "spores" that were budded off.

FIG. 28, *a–c*. *Stylorhynchus oblongatus*—Bütschli, after Schneider, A. Z. E. G., iv. —In *a*, a spore-cyst is burst and the spores come out in strings, reminding us of beaded filaments in karyokinesis, also of Figs. 7, 10, *a*, 19, *d*, 31, 41, etc. *b* shows a nucleus budding off spores, and *c* is a spore set free.

PLATE II.

FIG. 29, *a–b*. Nucleus of *Carchesium polypinum*—Greeff (see Kent, Plate 50).—The hyaloplasm does not appear constricted between the microsomata as in Fig. 31, etc. Each microsoma behaves like a nucleus and gets nucleoli, which themselves become cells like the germs of the "germ-balls." Sexual conjugation is reported as having preceded this state.

FIG. 30. *a–b*, Nucleus of *Actinobolus radians*—Entz, M. z. S. N., vol. v.—*a*, "germ-ball" state; *b*, stentor state.

FIG. 31, *a–c*. *Stentor polymorphus* (nucleus)—Stein (Kent, Plate 50).—The fork in *a* caused by branched budding of one of the microsomata. In *b* and *c* the chromatin has contracted to form itself into the reproductive state of germs.

FIG. 32. Portion of nucleus of *S. rœselii*—Claparède and Lachmann (Kent).—The nucleolus of the part segmented off becomes the nucleus of a new growth.

FIG. 33. Nucleus of *Urostyla grandis*—Bütschli (Kent).—"Germ-ball" state.

FIG. 34. Nucleus of *Acineta jolii*—Maupas, A. Z. E. G., ser. I, vol. ix. (Kent).

FIG. 35. Nucleus of *Plagiotoma lumbrici*—Stein (Kent).

FIG. 36. Nucleus of *Oxytricha*—Gruber, Z. w. Z., xli.

FIG. 37. Nucleus of *Chilodon cucullus*—Wrzesniowski, A. m. A. V., vol. v. (Kent).—The nucleolus in nucleated and a "paranucleus" resembling this subnucleolus rests against the nucleus.

FIG. 38. Nucleus of *Acineta fœtida*—Maupas, A. Z. E. G., ser. I, ix. (Kent).

FIG. 39. Nucleus of *Vorticella*—Gruber, Z. w. Z., xli.—Notice a paranucleus on the concave side of the "horse-shoe" nucleus.

FIG. 40. Nucleus of *Leucophyrs patula*—Kent, Plate 29.

Here are seen two paranuclei.

FIG. 41. Nucleus of *Loxophyllum meleagris*—Bütschli (Kent). Microsomata in act of dividing and so forming the beaded filament.

FIG. 42. Nucleus of *Loxodes rostrum*—Wrzesniowski, Z. w. Z., xx. (Kent).—Paranuclei accompany some of the sub-nuclei.

FIG. 43. Cell from *pedal ganglion of Arion*—Carnoy, p. 212.—The nucleus is in the form of a beaded filament in an "open" knot or tangle ("Knäuel").

FIG. 44. Nucleus of *epidermis* cell of an *Orchid*—Carnoy, p. 215.—The nucleus contains two reticulated nucleoli and a chromatic filament in a "close" tangle. The chromatin is in disks, and the intervening hyaloplasm is not constricted, hence the filament is not beaded.

FIG. 45. Nucleus of *epidermis* cell of *Salamander*—Carnoy, p. 219.—In *a*, a coarse reticulum is formed by fusion of the chromatic filament at various nodes of a close tangle. In *b* the connections have been broken, and a continuous filament once more formed, which, by shortening, becomes an "open" tangle, and the phases of karyokinesis follow. The chromatin is diffused throughout the filament. In *c* we see the chromatin withdrawing from the processes of the meshes and gathering in a definite path to form the beaded filament seen constructed into segments in *d*.

FIG. 46. Longitudinal optic sections of various *chromatic filaments*—Carnoy, p. 232.—To show the disposition of the chromatin. In all the chromatin is superficial, forming a thick wall in *a*, thin in *b*, thick with interior processes in *c*, and in *d* all gathered in annular segments distinct from one another.

FIG. 47. A filament dragged out of the nucleus by the section-knife, Carnoy, p. 234, shows that the chromatin is sometimes arranged in a spiral on the wall of the hyaloplastic filament, and may be pulled out like the threads from spiral ducts of plants.

FIG. 48. Fragment of a branching *Acinetan*—Bolton (Kent, Plate 47).—The nu-

cleus runs like an axis through all the stems and branches, and is segmented off into all the buds and spores.

FIG. 49, *a–h*. ***Amphibian pancreas cell***—Ogata, A. A. P. (Phys. Abth.) 1883.—The tissue hardened in warm corrosive sublimate is cut into thin sections and stained successively with ***hæmatoxylin***, ***nigrosin***, ***eosin***, and ***safranin***. Gaule, the author of this method, claims that there are two substances in the ***cytoplasm***, one ***eosinophilous***, the other ***nigrosinophilous***. There are also two substances in the ***nucleoplasm***, one staining best with ***hæmatoxylin*** (ordinary ***chromatin***), and the other best with ***safranin***. The ***chromatin*** is represented dead-black or heavily reticulated, the ***safraninophil*** is outlined only; the ***eosinophil*** is marked with parallel lines, the ***nigrosinophil*** by crossed lines and dots.

A. The nucleus lies imbedded in cytohyaloplasm (nigrosinophil) well marked on one side. On the other are the *zymogen granules* (eosinophil). A sparse reticulum, several small and mostly peripheral nucleoli (chromatin), and one large nucleolus, the "plasmosoma" (safraninophil), occupy the nucleus. In *b* the plasmosoma is migrating from the nucleus which now atrophies. In *c* the plasmosoma, now in the cytoplasm, begins to develop the two constituents of cytoplasm in its interior. It grows rapidly (*d*) to the size of the old nucleus, alongside which it lies. In *e* it has become still larger, and most of it has become transformed into zymogen granules and cytoplasm. In the centre of the remainder, *f*, a chromatin nucleus appears, which, later, differentiates in its interior, the plasmosoma and other nucleoli, *g*, *h*; and so we are back to stage *a* again.

FIG. 50. Nucleus of egg of *Colymbetes fuscus* (Will, Z. w. Z., xliii.), during ovigenesis and yelk formation.—*a*, reticulated; *b*, nucleolated; *c*, the chromatin growing and enlarging one or more of the nucleoli until all is homogeneous in *d*. It then buds off large and small cells; the former become reticulated and atrophy, the latter become follicle-cells. Then sheet after sheet of the nucleus dissolves off and is transformed to yelk-granules (*e*, *f*, *g*), the chromatin breaks down into granules, and microsomata of a beaded filament in a reticulum enclosing several nucleoli (*h*, *j*), and finally the karyokinetic spindle of the polar globule is formed.

FIG. 51. Nucleus of egg of *Ascaris megalocephala*—*b*, *c*, Van Beneden, A. B., iv.; *a*, Nussbaum, A. m. A., xxiii.—The multiplication of a single nucleolus produces one large nucleolated nucleolus (the "prothyalosome") and several smaller ones; *b*, the prothyalosome alone takes part in forming the polar globules, and its residue copulates with the male pronucleus; *c* is the nucleolus of the prothyalsome highly magnified, seen to consist in this stage of two disks, each of four-beaded filaments (the beads being the chromatic microsomata). Compare Carnoy, see Fig. 124.

FIG. 52, *a–c*. Nucleus of egg of *Pike*—Carnoy, p. 233.—In *a* we have a reticulum and nucleoli. In *b* the reticulum is broken up into nucleoli. In *c* these have fused to three.

FIG. 53. Nucleus of egg of *Nephthys scolopendroides*—Carnoy, p. 237.

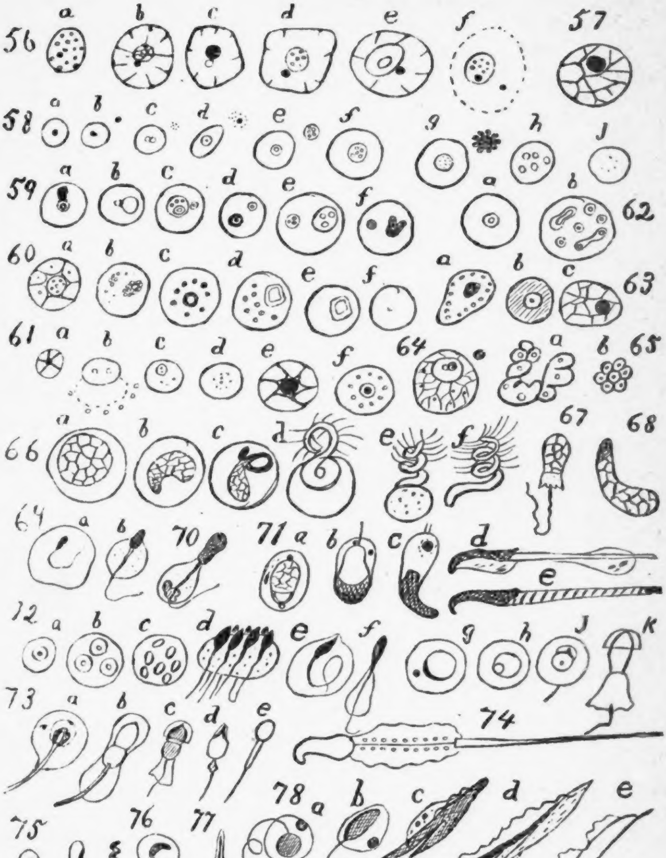
FIG. 54, *a–b*. Nucleus of egg of *Field-Mouse*—Rauber. M. J., viii.

FIG. 55, *a–b*. Nucleus of egg of *Perch*—Rauber. M. J., viii.—In *a* the microsomata are superficial and their processes suggest a reticulum; *b* is an optic section.

PLATE III.

FIG. 56, *a–f*. Nucleus of egg of *Arion* during ovigenesis and yelk formation, Platner, A. m. A., xxvi.—In *a* we see a nucleolus and microsomata and a paranucleus. In *b* the membrane of the nucleus shows the presence of a sparse reticulum, but the microsomata have concentrated to form a reticulated nucleolus, while the old nucle-

PLATE III.



olus is left outside as a paranucleolus. In *c* the nucleolus is homogeneous. In *d* it has microsomata, which fuse to one "nucleolus-nucleus" in *e*. Finally, in *f* the nucleolus has all the structure of the old nucleus of stage *a*. The membrane of the old nucleus now dissolves in the yelk, leaving the paranucleus as a "yelk nucleus."

FIG. 57. Nucleus of egg of *Toxopneustes*—Flemming.

FIG. 58, *a–j*. Nucleus of egg of *Spider*—Carus, Z. w. Z., ii.—In *b* a paranucleus appears, whose changes are as complex as those of the nucleolus. Finally, in *j* we have only a vesicle left.

FIG. 59, *a–f*. Nucleus of egg of larva of *Libelula*—Valette St. George, A. m. A., ii.—The structure of the large nucleolus in *c* reminds us of the entire nucleus of Fig. 51, *b*.

FIG. 60, *a–f*. Nucleus of egg of *Asteracanthion*—Van Beneden, Q. J. M. S., xvi. —The vesicle stage of *f* is reported finally to disappear.

FIG. 61, *a–f*. Nucleus of egg of *Rabbit*.

FIG. 62, *a–b*. Nucleus of *Conothyraca loveni*—Bergh, M. J., v.—Multiplication of nucleoli by division.

FIG. 63, *a–c*. Nucleus of egg of *Bat*—Beneden and Julin, A. B., i.

FIG. 64. Nucleus of egg of *Anodon*—Flemming, A. m. A., x.—A paranucleus is seen also.

FIG. 65, *a–b*. Nuclei of sexual cells ("primitive ova") of *Rana*—Nussbaum, A. m. A., xviii.—*a* of male, *b* of female. Budding of the nucleus in ovigenesis and spermatogenesis at this stage is often reported.

FIGS. 66–93 illustrate the formation of the spermatozoon from the nucleus of the "spermatid," and points in its structure.

FIG. 66. Antherozoids of *Hymenophyllum*—Carnoy, p. 226.—*a* shows the large reticulate nucleus of the daughter-cell of an antheridium. In *b* the nuclei is elongating, curved, and at its smaller end the net-work of chromatin is changing to the diffuse state. In *d* the pointed end protrudes from the cell and bears the locomotive cilia. This is homologous with the head end of a spermatozoon. The cytoplasm is gradually utilized as pabulum by the antherozoid, the residue remaining stuck to its hinder end *e* (which is finished last), to be finally fully absorbed or thrown off as at *f*.

FIG. 67. Spermatozoid of *Anodonta cellensis*—Carnoy, p. 225.

FIG. 68. Early stage of spermatozoid of *Salamander*—Flemming.

FIG. 69, *a–b*. *Human spermatozoa*, not yet freed from their matrix—Wiedersperg, A. m. A., xxv.

FIG. 70. Spermatozoid of *Elephant*—Weidersperg, A. m. A., xxv.—The head and tail project from the cell, the "neck" or "middle" piece is still growing. In the cytoplasm are the remains of the paranucleus.

FIG. 71, *a–e*. Spermatogenesis of *Rat*—Brown, Q. J. M. S., July, 1885.—*a*, nucleus of spermatid beginning its transformation. At one end the chromatin becomes diffuse, and here also is a ***head-corpuscle***. At the opposite end is a ***tail-corpuscle***. In the cytoplasm lies a paranucleus. *b* shows the fine ***axis of the neck and tail*** proceeding from near the ***tail-corpuscle***. In *c* the whole nucleus has become homogeneous, elongated and curved, and mostly protruded from the cytoplasm. *d* shows the sperm. nearly completed, a relic of cytoplasm remains sticking where the head and neck join, and another where the tail and neck join. The latter contains the remains of the paranucleus ("seminal granules"). *e* is the completed sperm. The neck shows a spiral structure.

FIG. 72, *a–f*. Sperm. of *Bull*—Kölliker, Z. w. Z., vii.; *g–k*, Brunn, A. m. A.,

xii. and xxiii.—The multiplication of the nucleus of the spermatogonium when the division of the cytoplasm is partially or wholly suppressed, causes several spermatids (and hence spermatozoa) to be united to or in a single cell, and so forming spermatogemmes. *a-d* illustrate this point, which with mammals is not the rule. The concentration of chromatin in one side of the nucleus near a head-corpuscle, the formation of a cap in connection with this corpuscle, is illustrated in *g–k*. The other granule is either the paranucleus or tail-corpuscle. In *k* the membrane covering the middle and hinder part of the head is lost or not separated away like the cap. The "collar" about the neck is the membrane of the old cell.

FIG. 73, *a–f*. Sperm. of *Rabbit*—Brunn, A. m. A., xii.—*a*, after Platner, A. m. A., xxv., shows the paranucleus, the cap and head-corpuscle, the chromatic head enveloping the forward end of the neck-piece or its axis. *b* shows the nucleus in two parts, the posterior portion grows smaller, the chromatin is concentrated in the anterior part of the anterior portion, which forms the head. *e* is from Schweigger-Seidel, A. m. A., i., to show the finished spermatozoon.

FIG. 74. Sperm. of *Mouse*—Brunn, A. m. A., xxiii.—Corpuscles arrange themselves about the axis of the middle piece and build it up, so that in the finished specimen the neck is annulated.

FIG. 75, *a–c*. Sperm. of *Sparrow*—Brunn, A. m. A., xxiii.—Here the cytoplasm spins a filament that winds spirally about the axis, but remains separate from it.

FIG. 76, *a*, *b*. Sperm. of *Pigeon*—Kölliker, Z. w. Z., vii.

FIG. 77. Sperm. of *Triton*—Schweigger-Seidel, A. m. A., i.—The sinuous filament represents the thickened edge of a delicate membrane, which slings it to the tail like a mesentery. See Gibbes, Q. J. M. S., xix., for same structure in salamander, and Fig. 78, *c–e*, for the frog.

FIG. 78, *a–e*. Sperm. of *Bombinator*—Valette St. George, A. m. A., xxv.—*e* is the skeleton left after macerating away the sarcode.

FIG. 79, *a–e*. Sperm. of *Raja clavata*—Jensen, A. B., iv.

PLATE IV.

FIG. 80, *a–e*. Sperm. of *Branchiobdella*—Voigt, A. z. z. I. W., vii.—In *a* we have a large nucleus, to which is fastened a *tail-corpuscle;* we have also a small paranucleus, but this grows, fastens itself to the nucleus at the end opposite the *tail-corpuscle*, and proceeds to spin a spirallated piece like the middle piece of Figs. 71, 79, etc., but it here has the place of a head-cap, though its functions are probably unchanged.

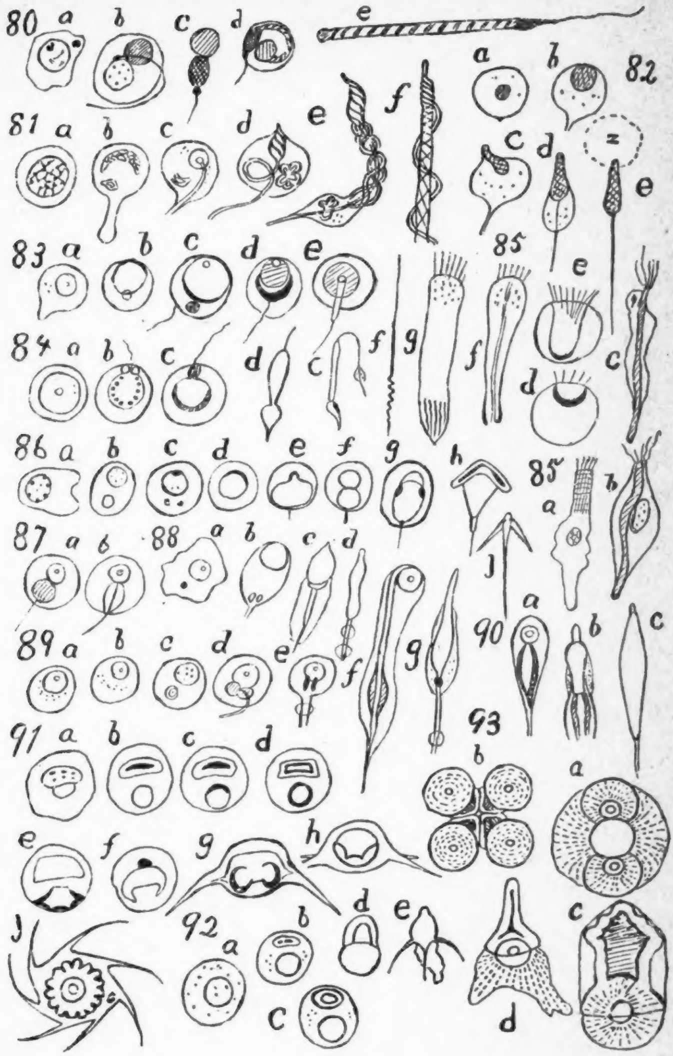
FIG. 81, *a–f*. Sperm. of *Helix*—Platnèr, A. m. A., xxv.—Here the nucleus buds off a paranucleus, then concentrates, becomes homogeneous, an axis appears, over its end the nucleus invaginates itself, while the cytoplasm containing the paranucleus spins three spiral filaments; two of these closely invest the axis, the third remains free.

FIG. 82, *a–c*. Sperm. of *Cassiopeia*—Mereschkowski, A. Z. E. G., x.—In *c* the dotted line is a portion of the circumference of the "blastophore," the protoplasmic "cell" which bears the spermatozooids imbedded by their heads over its surface.

FIG. 83, *a–e*. Sperm. of *Cucumaria frondosa*—Jensen, A. B., iv.—Head- and tail-corpuscles are seen. In *e* a middle piece in connection with the tail-corpuscle is seen. The spermatozoon is still unfinished.

FIG. 84, *a–g*. Spermatazoon of *Paludina vivipara*—"hair form" (functional), Brunn, A. m. A., xxiii.—In *b* are seen two tail-corpuscles and peripheral microsomata of chromatin that diffuse in *c*. *f* is the finished sperm., *g* is a bundle of them.

PLATE IV.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89 a b c d e f g
90 a b c
91 a b c d e f g h
93 b a
92 a b c d e
c d c

FIG. 85, *a–f*. Sperm. of *Paludina vivipara*—vermiform (not functional), *a–c*, Carnoy, p. 228.—The nucleus here plays no direct part in the formation, but acts like a paranucleus. *d–f*, Brunn, A. m. A., xxiii. The nucleus is here represented as directly concerned. Compare *f* and 84, *g*.

FIG. 86, *a–j*. Sperm. of *Locusta viridissimi*—*a*, *b*, and *h*, Valette St. George, A. m. A., x.; *c–j*, Brunn, A. m. A., xxiii.—Here, as in Fig. 73, the head (*f*) divides into two parts, the anterior of which contains the chromatin.

FIG. 87, *a*, *b*. Sperm. of *Forficula auricularia*—Valette, A. m. A., x.

FIG. 88, *a–d*. Sperm. of *Stenobothrus*—Valette, A. m. A., x.—The middle piece (at least its periaxial portion) is formed directly from the paranucleus.

FIG. 89, *a–g*. Sperm. of *Blatta germanica*—Valette, A. m. A., xxvii.—The paranucleus is reported as formed from a granular mass, and it evidently is built into the "middle piece." In *e* and *g* globules of cytoplasma are seen sticking to the flagellum (neck [middle piece] and tail).

FIG. 90, *a*, *b*. Sperm. of *Agrion*—Bütschli, Z. w. Z., xxi., pp. 402 and 536. *c*, *Hydrophilus*. (*Clausilia*, *Acridia*, *Clythra*, etc., agree closely with Figs. 87, 88, 89, 90.)

FIG. 91, *a–j*. Sperm. of *Astacus*—*a–g*, Grobben, A. z. I. U. W., i.; *f*, *h*, *j*, Nussbaum, A. m. A., xxiii. *j* is view from above.

FIG. 92, *a–e*. Sperm. of *Eupagurus*—Grobben, A. z. I. U. W., i.

FIG. 93, *a–d*. Sperm. of *Ascaris megalocephala*—Van Beneden, A. B., iv.—*a*, Spermatocytes forming from the spermatogonium. The two nuclei are united by the *spindle*. In *b* spermatids have formed, held together in a spermatogemme by a "cytophoral" portion (in which is a "*refringent body*" connected with each spermatid, homologous with paranucleus). *c*, the mature sperm. The nucleus is situated in the head, which is left uncovered by the thin membrane that covers the remainder. The "refringent body" is large, and fills up nearly the entire body. *d*. Here the refringent body is small, the protoplasm about the nucleus in the head, amœboid. The microsomata of the cytohyaloplasm, seen in rows, mark the nodes of a regular reticulum.

FIGS. 1–13, 25, 66–68, 71, 81, 93, illustrate the *structure of protoplasm*.

FIGS. 1, 2, 6, 16–18, 22–34, 49, 59, 66, etc., illustrate the "*individuality*" *of the nucleus* or of its subordinate parts.

FIGS. 13, 14, 17, 19, 20, 28–51, illustrate the different *forms of nuclei*.

FIGS. 8–10, 13–15, 19, 20, 26, 28, 43–47, 49–61, illustrate the *different conditions and morphological structure* the nuclein may assume aside from the changes of *karyokinesis*. Still other examples will appear when *karyokinesis* is considered.

FIGS. 50–64 (exc. 62) illustrate the *structure of the "germinal vesicle*."

FIGS. 66–93 illustrate the *structure of the spermatozoon*. (Only a small piece of the tail has in each case been represented, to economize space.)

FIGS. 36–40, 42, (44?), (49!), (50?), 56, 58, 64, 70, 73, 78, 80, 81, (83?), 84, 86–93, indicate the presence of a *paranucleus*. Other cases will be given under *karyokinesis* and *fertilization*.

I.—Introduction.

"WHAT is the significance of *sex?*" is a special inquiry in the more general field of research included under the head of *Reproduction;* but nearly all the problems of the larger subject must be investigated if we wish to elucidate the more special one. The question presents both morphological and physiological aspects. Thus, we need to know the intimate structure of the sexual cells in the different plants and animals and the modifications this structure undergoes from the time the cells are generated until fertilization is effected. We can in this way compare the ovum and the spermatozoon and perhaps learn whether their functions are alike or different, and in what they differ. But we must also know how they compare with other cells, and are therefore at once compelled to treat the general subject of *Cytology.* This may conveniently be done in the following order: (1) Cell-structure in general. (2) The structure of sexual cells; the ovum (practically the germinal vesicle) and the spermatozoon. (3) The phenomena of karyokinesis. (4) The phenomena of fertilization.

Then in the next place it is necessary to make a comparative study of the methods of reproduction in the groups of living beings, following the phyla of evolution. In unicellular organisms we shall be mainly interested in the various ways in which reproduction is effected and the relation of these to the action of environing circumstances. Here we may see the origin of sex and henceforth trace its evolution. Then as we see how the multicellular individual arose from the unicellular one, and as we trace the evolution of more and more complex forms, differentiating into more and more numerous groups, the relations of the sexual method to other methods of reproduction will gain in interest and be best considered under the heads of *Alternation of Generations* and of *Parthenogenesis.* We shall also be specially interested in following the genesis of the sexual cells during the life-history of each individual, and so be involved in the mazes of *ovigenesis* and *spermatogenesis.* Incidentally *hermaphroditism* should be touched, and finally the morphological side of the question must conclude with a discussion of the significance of the *polar globules* and allied points.

Then on the physiological side, there is a vast and fruitful field both of accumulated facts and promising experiments for future research. The numerical relations of the sexes under fluctuating conditions so comprehensively discussed by Düsing in his memoir on the "Regulation of the Sexual Ratio," first invite our consideration. Next we cannot escape a discussion of the problem of *Heredity*, because this is the very soul and centre of all these other problems; and finally we must necessarily conclude by discussing the doctrine of the *Genesis of Species.*

We thus see that this inquiry is one of vast proportions, and can understand why it is still unsettled, in spite of the flood of speculations that all ages have poured upon it because of its absorbing interest and importance. But all except a very few of these attempts at a solution of the problem of sex are of no scientific and only of slight historic value. We shall only attempt a summary of our *present* knowledge of the subject as a *foundation* for future progress.

The stimulus this kind of research received through the labors of Darwin has not been effected in as great a degree among English-speaking savants as with the Germans. It is desirable that more interest in this subject be awakened among American naturalists, not alone for the sake of national pride, but also because the obscure recesses of this great problem can be illuminated only by the combined labors of many minds.

The earliest thinkers, acquainted only with the highest forms of life, naturally supposed that the interaction of the two sexes was necessary to produce a new being. Some, as Hippocrates and Galen, supposed that the two parents contributed equally and in a complementary manner to this achievement; others, as Aristotle, Fabricius, Harvey, thought that one parent was subordinate in his influence, being a mere stimulus to development. The discovery of the *ovum* and *spermatozoon* gave more definiteness to these theories, and so arose the schools of the *ovulists*, who saw in the spermatozoon a fertilizing element of the ovum, and the *spermatists*, who thought the ovum or the uterus to be a *nidus* where the *spermatozoon* was nourished and developed to the new being. Advancing knowledge dispelled the latter views and modified the former, but now arose the controversy of *evolution* vs. *epigenesis*, and so for a season attention was diverted from the main problem of the significance of sex.

Spontaneous generation once accounted for the presence of the swarms of minuter forms of life, but scientific study, aided by the microscope, showed that these lower forms of life multiplied by methods obtaining with the higher forms, and the doctrine of spontaneous generation was, by Tyndall's beautiful experiments, finally banished from the realm of the minutest infusorial life,—to which, as a last resort, it had been restricted. But, with the establishment of the law that all living beings are derived from pre-existing forms of life, we also learned that another method of reproduction, the asexual (agamogenesis), was more widely used by nature than the sexual one, and increases in importance as we descend the organic phyla,—is, in fact, the foundation on which the latter rests, and out of which it has been evolved as a rare and expensive, but useful, link in *generation.*

It is now a half-century since biology received its organon in the formulation of the *cell-doctrine.* From this doctrine we must start in every biologic inquiry. Stated briefly and in the light of the present, it stands thus: The body of any of the larger plants or animals is a mass of minute units, called *cells*, that are organized in a complex way into different orders of higher units, or parts, known as *tissues* and *organs.* The unity or *individuality* of the organism is secured by the harmonious working together of its organs, like the parts of a *mechanism*, towards simple results for the good of the whole. All living beings, compared as to structure (morphology), naturally fall into groups that are related like the branches of a tree (phylogenetic classification). At the roots we place the unicellular beings, then, as we reach the lowest and least subdivided branches, we find organisms represented by simple aggregations of cells like those which lower down live as independent beings; and, as we rise along the phyla, such aggregates become more and more complex in organization. In the development (ontogeny) of an individual its organization is established in the following manner. We start with a single cell, which produces an aggregation by continued self-division, and then the units differentiate into the tissues and organs, becoming successively more and more complex, so that the embryologic history—leaving out of consideration secondary or *cenogenetic* modifications—is a repetition of the stages seen as we ascend its phylum in the natural system. Such relations as these could have been established only by the actual evolution of living

beings along these lines, in the past history of the earth; and this is confirmed by the *paleontologic* record. We are thus convinced that organic beings are *genetically* related, and, therefore, the phenomena of reproduction and the question of sex must be considered in relation to the problem of the genesis of species.

The laws of organization of biologic beings find their analogues in civil and social organizations. Hence we often speak of the animal as the *cell-State*. As civilization progresses and *Society* is evolved, the unit, here the human mind, becomes more and more specialized in its activities, and the individual more and more dependent for his existence and welfare upon the fact that he is *part* of an organism,—the *State*,—which is complexly organized of many interworking and subordinate parts. How wonderful are the life manifestations of a State! and yet nothing is done except by the activities of the faculties present in each mind. The *division of labor* causes each function to be more efficiently exercised; but, what is more important, it is the *form* in which this is organized that impresses us and that makes the *individual*. In a similar way, a man may be said, philosophically speaking, to be only a developed amœba, even as a State is a man on a larger scale.

We are thus enabled to understand what is meant by the *Individual*. This term is purely relative, for in an organism where the subordinate units still retain a large measure of independence, the individuality of the lesser units detracts from that of the larger; indeed, the latter is not thoroughly established until the former is sacrificed, when the lesser units are so mutually dependent as to be mere *parts*. When this stage is reached the existence of the lesser units depends on the existence of the greater unit. Thus, when the organic relations or functions in a man's body are disturbed, not only does the man die (cease to exist) as an individual, but the cells also dissolve into the less highly organized substances of "non-living" matter. *Life* may then mean one or both of two things: 1, the activities of the organism (this is of course a mere summation of the activities of the cells); 2, the *form of organization* of these activities; this is a *relation*, an *abstraction*, but is necessary for the existence of life in the former sense,—*i.e., it makes the individual.* The controversies so often arising about these terms can only be due to a misunderstanding of the cell-doctrine.

There is, however, this difference between the *biologic* and the *social* individual,—the latter can be formed by *association* of units at first independent, while in the former *the cells are always genetically related.* The metazoa arose from the protozoa by a modification in the mode of reproduction by self-division, which caused the daughter-cells to remain united. Now, let all the other phenomena and forces remain as before, these daughters will soon divide again, they will not separate but will go on for a considerable period until an aggregate of cells results, then by the operation of the principles that produce *alternation* of *generations* in separated forms and *polymorphism* in *colonies*, there will follow what we term the *differentiation of tissues*, and lo, a metazoon. In a similar way, *among the Metazoa a multisegmented form must have arisen from one unisegmented by modified budding or strobilation.* Natural selection will account for the preservation of forms, but the cause and origin of new forms lies in the above laws of *organization.* We are now prepared for the next step in this argument. As *self-division* is the only form of reproduction that could give rise to the Metazoa, we understand why this is the mode which alone operates during ontogeny. It is also the usual mode of reproduction among the Protozoa. Once in a while under hard conditions of nutrition, etc. (perhaps so only as to its origin—Weissmann), the protozoan individual, too feeble to fight the battle of life alone, fuses (*conjugation* with a neighbor (sometimes more than one?), and thus reinvigorated goes on in its former way again. Possibly *conjugation* is only one, though the most useful, of several methods by which *rejuvenescence* can be effected; at any rate we can see that by "sexual reproduction" we do not mean a new mode of reproduction contrasted with the asexual mode, but simply *a particular mode of a sexual reproduction preceded by a particular method of rejuvenescence* (conjugation, fertilization[1]). Now when the Metazoa were formed by the non-separation of cells produced by binary division, those cells that required rejuvenescence were set free that they might conjugate, and *this is the origin of the ova and spermatozoa.* All the cells resulting from the repeated binary division of the fertilized egg are *homodynamous*, but all could not leave and be fertilized, because many were needed to differentiate into the various

[1] Van Beneden, Archives de Biologie, iv. p. 616.

tissues for the good of the whole. Even some of the generative cells had to serve their more fortunate brethren by giving origin to the accessory parts of the *generative tissues* that a few cells might be successfully prepared to perpetuate the species. All the tissues, including the *generative*, are based on a stroma of undifferentiated, "embryonic" cells, capable of dividing as they have in the past, and differentiating into their proper tissue when they have the chance, as in *regeneration* of lost parts. These cells are all the descendants of the original egg, and homodynamous with it and each other as if they were separate amœbæ. But after a certain number of divisions they lose the power of dividing further without fertilization and then they differentiate. Only the cells differentiated in the direction fitting them for fecundation ever get a chance to be fertilized.

Possibly this want of fertilization, more and more increasingly felt by the embryonic cells as they continue their final divisions, may explain *senescence;* but so long as we do not understand the nature of senescence in the Protozoa we cannot understand it in the Metazoa.

Growth is due in the Metazoa to the double process of cell-multiplication and cell-growth. May we not say that cell-growth is also partly a result of a reproductive process, and that the cell is a living unit by virtue of being organized? There can now no longer be a doubt of this. We can no longer speak of animals as "evolved from a homogeneous bit of jelly." Cells and the Protozoa and Protophyta in general, may be considered as illustrating as wide a diversity of differentiation and gradation of organization as we see exemplified in the larger units or in the social units (societies and states). We cannot conceive of life without organization. *The homogeneous cannot be called living.*

The cell-wall at first was thought of importance, but soon it was seen that this was a secreted product, and so its gelatinous contents, called *protoplasm*, next became the definition of a cell. But most cells had one or more "nuclei" in them, and this was conceived as a differentiated product of the protoplasm. Continued study of the *nucleus* raised its importance more and more, until at present some eminent cytologists are ready to make it the essential part, and the surrounding plasma almost as secondary as the cell-wall itself. Believing this to be the true view, we are ready to consider,—

II.—The Significance of the Cell-Nucleus to the Problem of Sex.

(*a*) CELL-STRUCTURE IN GENERAL.

Microscopic examination of cells in the living state, or treated by the simple *hardening*, *staining*, and *section-cutting* methods of a few years ago, can give us only a superficial knowledge of cell-structure. With such methods the first step taken was to distinguish the protoplasm as differentiated into the outer membrane or *cell-wall*, the more fluid and granular *contents*, and the generally spherical and central *nucleus*. The last body often carries a *nucleolus;* and nucleus and nucleolus may sometimes be increased in number, or, again, they may apparently dissolve to be later reconstituted. Our next step under this technique was to distinguish a primary and a secondary plasma,—the former the *protoplasm* proper, the latter the *deutoplasm* (paraplasm, metaplasm, etc.), formed by processes of *absorption*, *assimilation*, and *degradation* of the protoplasm. The former is active, *life-substance*, the latter passive, *food-substance*. The protoplasm is more firm and hyaline, abundant near the wall and the nucleus, and forms coarse trabeculæ, traversing and bathed by the deutoplasm. The latter substance is mainly "cell-sap," in which float *granules*, oil-drops, yolk-spheres, etc. The difference in the size of cells is due mainly to difference in the amount of deutoplasm they contain. We are not surprised, therefore, to learn that the yolk of a hen's egg is homologous with a microscopic cell, but we cannot say that it contains no more pure protoplasm than the latter.

The third step was taken as a result of studies of the phenomena of fertilization. The nucleus of the egg, the *germinal vesicle*, often shows a structure quite comparable to that of a "typical" cell, and the fact that it was seen to conjugate with the spermatozoon certainly pointed to its *autonomous* nature; but at first the true import of this conclusion was obscured by theories as to the multicellular nature of the ovum.

Our knowledge of the cell has, owing to improved technique, been wonderfully advanced during the last decade by the labors of cytologists, led by Strasburger and Flemming; and at present the work of Carnoy and of Gaule promises a new era in which the science of the cell shall rise to the dignity of a grand division of biology. We shall treat of *Cytology* only so far as a knowledge

of it prepares us to understand the import of *fertilization* as a morphological problem.

No one cell described in detail could be taken as "typical." It would be as absurd as to describe a horse as a typical animal. But the horse has tissues which are similar to those of widely different animals. So with protoplasm; it has a typical structure generally obtaining,—viz., *it is reticulated.* The *reticulum* is easily seen in "multipolar" nerve-cells, but almost any cell, when properly treated, will reveal it. (See Figs. 1–13.) A coarse reticulum has its trabeculæ themselves more finely reticulated. The reason for this structure is obvious. The thin threads of protoplasm are bathed by the cell-sap (the *enchylema*), and so the processes of *nutrition* and of *respiration* take place with rapidity. In the protoplasmic reticulum two elements are distinguished,—the clear *hyaloplasm*, which serves as a matrix for granular bodies of various sizes,—the *microsomata.* The microsomata are formed by the growth or the fusion of exceedingly minute grains, to which the term *granules* may be restricted. Then in the nucleus, when the microsomata grow or fuse to a few larger bodies, they readily come to be designated *nucleoli.* So these terms simply refer to size and not to definite substances, for one and the same substance occurs in all these forms, and there is every reason to believe that several different kinds of protoplasm occur in the form of these microsomata.

Another distinction is also made in that the protoplasm outside the nucleus is called *cytoplasm*, and that forming the nucleus is the *karyoplasm* (nucleoplasm). From this we get the terms cyto-hyaloplasm, cytomicrosomata, cyto-enchylema, or cytenchyma; and, correspondingly, karyo-hyaloplasm (karyaloplasm), karyosomata, karenchyma. Chemically, the *karyosomata* contain "*nuclein*," which is generally termed "*chromatin*" because of its great affinity for "stains." Gaule believes that he can differentiate two constituents of the karyosomata and two of the cytoplasm. He restricts the term chromatin to a substance having most affinity for *hæmatoxylin*, and gives the term *plasmosomata* to those nucleoli that especially fix *safranin.* The microsomata of the deutoplasm are said to especially stain by *eosin*, while *nigrosin* has a special affinity for ordinary protoplasm (cytaloplasm or cytosomata, he does not distinguish which). (See Figs. 49 *a–h.*)

It is pretty certain that protoplasmic movement is due to the al-

ternate contraction with thickening, and stretching of the fibres of the reticulum. The nodes of the reticulum come closer together in some one direction, and get farther apart in the direction at right angles to this; at the same time the microsomata at the nodes absorb the intervening microsomata. This looks as though the matter of the microsomata was subject to mutual attractions and repulsions, and then we could say that muscular movement is a special manifestation of those varied phenomena of division and fusion, attraction and separation of microsomata seen in karyokinesis.[1] However, this generalization cannot be made so long as we are uncertain whether the hyaloplasm or the microsomata are the primary thing, or whether they are independent but mutually reciprocal. If the microsomata (granules) are primary, then we must assume that the hyaloplasm is an aggregation of a special sort of these granules in a definite way to serve a definite function. From the optical properties of the hyaloplasm this structure must be regular and uniform. Others of these granules differentiate in various directions to serve various functions, and form, by various degrees of aggregation, the different sorts and sizes of microsomata. The primary granules from which all these other forms of protoplasm in the cell are derived must be endowed with the power of *growth*, of *reproduction* by simple division, and of differentiation or variation. They would be affected by stimuli and vibrations travelling in the hyaloplasm in which they live. They should be designated *gemmules*, because of all these properties. The *cell, on this hypothesis, is a gemmule state;* it is a complex organism, with parts structured and differentiated for special ends for the good of the whole. The membranes for protection and osmosis, the reticulum for movement and transmission of sensations, the gemmule for assimilation and reproduction. Degraded gemmules like differentiated and degraded cells form the various kinds of microsomata in the deutoplasm, and build up other parts of the cell. We shall see that the facts of cell-structure, of karyokinesis, and especially of fertilization, lend great weight in favor of this hypothesis. The *gemmules are the idioplasm.* They build up the cell in its peculiar characters and maintain it there. Under the above hypothesis the theory of Nägeli as to the structure of idioplasm will apply to the struc-

[1] See Figs. 12 and 93, *d*, and consult Van Beneden, Arch. Biol., iv. p. 343, and Melland, Quar. Jour. Mic. Sc., xxv., July, 1885.

ture of the gemmule, and not to the reticulum primarily as Nägeli intended. But the discussion of this point belongs under the subject of heredity.

It may be asked, what is gained by putting back the problems of life—of assimilation, of reproduction, and of heredity—one step; are they not as inscrutable as before? Undoubtedly they are, but we gain greatly by such a view as this. We can better understand the cell. Just as we simplified the problem of *life* as applied to the higher animals, by the cell-doctrine, so we simplify by as great a step this protean problem by means of the gemmule hypothesis. We must accurately determine what are the real labors of the gemmule out of which, by organization, the more wonderful phenomena of cell-life grow, and then we shall see that we have spanned by a large fraction the chasm between non-living matter and living matter. The albumen molecule is a very minute thing when compared with the gemmule, and there is plenty of room for one or two *stadia* of organization between, that would, when known, simplify the problem completely. On this hypothesis, also, cells must have a life-history in which they pass through stages of development and stop in various degrees of complexity as mature cells. The more highly organized cells must pass through the stages in which the less highly organized remain; and there is room here also for a *phylogeny* and for *cenogenetic* modification. Finally, the simplest cells we know, must be to some extent modified from the condition in which the original cell was. This must be taken into account in trying to derive "living" protoplasm from "non-living" matter. The first gemmule could arise only by organization of a lower order of life, and the first cell must have been an aggregate of like gemmules produced by binary division of a mother gemmule. Reproduction in this hypothetical first cell we may reasonably suppose to have been effected in two ways,—either by a division of the gemmule colony into two smaller colonies, or by a dissolution of its members when each gemmule was set free to become the progenitor of its own cell-state. When differentiation came in, the primitive mode of reproduction became modified, as follows: A few only of the gemmules were kept undifferentiated for purposes of reproduction. The others had to serve these, helping them to get better chance of food by carrying the colony about by amœboid or ciliary motion; others

to give protection; others, to furnish a special breeding-place for the gemmules differentiated into the nucleus; and so on. When the gemmule was set free, it more and more had to be protected by special envelopes, and so arose spores. When all the gemmules free for reproductive purposes went into the spores, the protoplasm remaining after the spores were set free could no longer grow, and hence live, and thus in reproduction by spores, as in gregarines, the mother-cell was left as a *corpse* when this sort of reproduction was exercised. (Fig. 27, *e.*)

But reproduction by binary division still continued, modified first as budding, where some of the reproductive gemmules were pinched off with a share of the cytoptasm. Here we must call attention to the fact that the *individuality of the cell does not depend on the number of idioplasm gemmules in it*, for all these, being undifferentiated, are, as it were, embryonic or *alike* and *mutually autonomous.*[1] They continually grow and divide, and two, resulting from one, do not produce a different kind of effect, but only more work than one. Indeed, the effect produced is not seen until they differentiate, and so present the characteristics of the cell. *This principle is extremely important for understanding the facts of fertilization.* It makes no difference whether the reproductive element set free contains *one or a million* gemmules, except that in the former case it *takes longer* to make as large a cell as the mother; in precisely the same way as it takes longer to raise a hydra from the unicellular egg than it does from the multicellular bud. The reproductive gemmules being now confined to the nucleus, binary division resulted in nuclear division; so far as it was advantageous that a large plasmodium-like cell should be produced, the new nuclei remained and nourished the common cell; and so far as the spreading of the cell over the habitat was of advantage, each daughter-nucleus took its half of the cytoplasm, thus producing cell division. This subject will be continued under the head of Karyokinesis. Continued binary division of the nucleus and the development of the products while the mother-cell remains undivided results in *free cell formation* (at least one variety of this). These cells often play the rôle of spores, and what is of importance when this is the case, the size of the spore is reduced in proportion to their number,—*i.e.*, to the number of divisions. In a number of the monads these spores are so

[1] Compare Nussbaum, Arch. f. Mic. Anat., xxvi.

minute as to be visible, only as a cloud of refringent points, under a magnifying power of four thousand diameters. (See *Roy. Micr. Journ.*, April, 1886.) Dallinger saw these points grow until they attained the size of nuclei, then there was differentiated a narrow zone, which increased in width around the nucleus and formed the cell. At the time this zone first appeared the hitherto homogeneous nucleus differentiated microsomata within it. (See Fig. 98, *a–e.*) As the flagellates seem to be the lowest of the forms of life in which all other groups converge, we should expect here the most primitive methods of reproduction. This mode of spore formation follows conjugation: the nucleus spreads by a sort of dissolution through the plasma as in the case of the cyst forms. When the latter is broken, these spores imbedded in a plasma fill it. Have we not here a direct reduction to the gemmule condition, each gemmule being given a chance to start a new cell, *i.e.* a gemmule colony?

From the simple modes indicated above, we can easily derive the methods of reproduction obtaining among the Protozoa. If the whole or a part of the nucleus segments into spores which remain in a "brood pouch" in the cell-body, and are liberated as motile young, we get the "*germ balls*" of Stein. Compare Figs. 22, *d*, 23, 29, 30, 32, 33, 34. The structures here indicated are similar, but in many cases these nucleated bodies simply represent a stage of development or of kinesis of the nucleus, and are not liberated as spores. Bütschli is inclined to disbelieve in this mode of reproduction, but it hardly seems as if his objections sufficiently disprove the evidence we have of its existence.

If the chromatin, instead of remaining uniformly distributed in the nucleus, gathers into a particular body, which sustains the relation of a nucleus to the old nucleus, we get a *nucleolus*. This is a structure very generally found, especially in highly developed cells. The nucleolus is to be conceived as the primary body and the nucleus as secondary. Before the nucleus can divide the nucleolus must divide; but here we may get multinucleolated nuclei by the multiplication of the latter, while the former remains undivided. The general law of cell-life seems to be to conserve in the centre of protoplasmic bodies a supply of undifferentiated or primary substance (the *idioplasm*), and to surround this by concentric structures that protect it, and serve as organs of relation to the external world. The external envelopes

are derived by differentiation of this inmost substance. This idioplasm is continually throwing off centrifugally these secondary substances, and the continued life of the cell depends on its integrity. Reproduction always means that a portion of this substance has been separated from the remainder, and so acts from a new centre. The secondary plasmas are *mechanisms* for effecting such separations, as well as organs for other purposes. *Alt the biological manifestations of cell-life are due to the activity of these organs.* All the idioplasm does is to *grow*, by the growth and continual division of its gemmules, and to *differentiate*, by *organizing* in various relations for the different organs, perhaps accompanied by the chemical degradation of the units. What the chemical processes are that take place in the idioplasm unit, by which it grows and reproduces, must be referred for discussion to the subject of *Heredity*. The above is not an explanation, but simply a statement of the facts of heredity, as we conceive them, in this connection.

The forces active in the gemmule are, of course, the primary cause, and the reason for and explanation of the activities of the secondary plasmas, which activities are, as was said above, the phenomena studied in biology.

We can understand, in this light, how we always have structures and processes that obtain in one stadium of organization repeated in the higher, compound, or derived stadia. For this reason the nucleus is, when far enough developed, reticulated like the cell, and the nucleolus itself often repeats the structure. (See Figs. 2–13.) In the same way as we get three concentric structures simultaneously existing (Figs. 9, 13–15, 19–22, 26, 32, 42, 44, 49, 50–64), we may have a quadruple condition (presenting one or more nucleoli in the nucleolus), seen in Figs. 13, 26, *f*, 27, 33, 51, 53, 56, 58, 64; and possibly Fig. 56 is evidence of a quintuple state. The central body is always capable of generating the whole cell by a differentiation of its chromatin (see Fig. 49), and the central body of this new cell has like powers, and so on indefinitely.

We often have the nucleus or the nucleolus dividing into parts that are of unequal value, thus giving *chief* and *accessory* nuclei or nucleoli, as the case may be. (See Figs. 44, 49, 51, etc.) In this case the chief body only retains the reproductive function, and can, by suitable stains, be differentiated from the accessory

bodies. In this way Carnoy and Gaule have shown that such stains as hæmatoxylin and carmine are not tests for chromatin in a restricted sense, but that we must use safranin and methyl green. It is indeed a remarkable property of the idioplasm that it has a special affinity for aniline dyes.

In connection with the segmentation of the chromatin comes up the question of individuality. Is a multinucleated cell a single cell? If we understand that the chromatin is composed of many small units, like the soldiers in an army, we see that it can divide into bodies of various sizes, and these bodies can fuse again, just as the different divisions of an army may combine for any operation and separate once more for other duties. Such phenomena of the multiplication of centres of chromatin activity are illustrated in Figs. 1, 24, 25, 31, 42, and 48, or by a colony of flagellates, of hydroids, or by a tree.

Are all the bodies we see, such as nucleoli and granules in a nucleus, the result of *binary* divisions or of simultaneous segmentation of a single nucleolus, or are they produced by a sort of general dissolution? Conversely, what are the laws by which the different orders of bodies from granules to nucleoli are built up? This question is to a large extent obscure as yet. The phenomena to be explained in this connection are illustrated by Figs. 14, 15, 19, 26, 50–63. Even nuclei fuse (as see Figs. 94 and 97, *c*), and the sexual nuclei.

In some low forms of cells and in higher cells degraded by parasitism, such as yeasts and moulds, the nucleus may never take on the form of a compact body, but be present in the protoplasm in a diffused or granular condition. (See Figs. 14 and 15.) In karyokinesis and in maturation or development of nuclei, there seem to be phases in which this condition is represented.

Finally, we consider those forms of nuclei and of nucleoli where the spherical or elliptical shape is departed from to a large extent. Such are the *filamentous nuclei*. These are usually moniliform, being due to incomplete segmentation and to growth in one direction. (See Figs. 7, 19, *d*, 20, *b*, *c*, 28, 30, *b*, 31, 41, and 42.) In the higher tissue-cells, the *chief nucleolus* is present in this form, often being exceedingly long, and wound about in a way so as to give a reticulated appearance to the chromatin. It has been termed the *knäuel* by the Germans, which term means a *tangle*, usually termed a "skein" in English works on karyokin-

esis. (See Figs. 13, 19, *b*, 43, 44, 45, 46, *a–d*, 47, etc.) In Figs. 13 and 47 we see the chromatin present in these filamentous nucleoli has been complexly arranged in a reticulum and in a spiral respectively. A cross-section of one of these filaments (mitom of Flemming) cannot be distinguished from a section of a spherical nucleolus of like structure.

[NOTE.—After the above article left my hands an important paper by Altmann ("Studien über die Zelle," Leipzig, 1886) came to my notice. By means of fuchsin staining, followed by a wash of picric acid, a new element, the "*granula*," is brought to notice in the cytenchyma. These *granules* have hitherto been included with the cytenchyma in the general term *deutoplasm*, but Altmann believes they should be elevated to the dignity of an element in the protoplasm. To them Altmann ascribes the function of initiating and sustaining the metabolic or vegetative activities of the cell, while the reticulum mediates the motile functions. Morphologically, they are seen to grow and to multiply by fission or budding, so that he has formulated the law "*omnis granula e granulo*." He conceives the nucleus and nucleoli to be aggregations of granules, as are also the chlorophyl-corpuscles. (Compare Schimper, *Botanische Zeitung*, 1880 and 1883.) All this falls into line with the gemmule hypothesis, but the function of these granules cannot be so primary as he believes, if we are to credit the evidence obtained from experiments on enucleating cells. (See Nussbaum, A. m. A., xxvi.) Nussbaum found that if he cut an *Opalina* to pieces, the pieces deprived of nuclei continued to manifest movement, but did not grow. On the other hand, those pieces that had nuclei regenerated their lost parts. It is worthy of note that if a new formation was once in process of development, this was completed, even though the piece was enucleated during the process. This can be understood if we suppose that gemmules destined to repair the tissues had already migrated from the nucleus, though, of course, we are not confined to this explanation.]

(*b*) STRUCTURE OF THE SEXUAL CELLS.

In speaking of the sexual cells without distinguishing the ovum from the spermatozoon, it is useful to use the word *gamete*, from which we readily coin another useful word, *gametogenesis*, as including *ovigenesis* and *spermatogenesis*. In the present section we are concerned only with the changes which the nucleus of the gamete suffers after its final division in gametogenesis.

It is well known that in the earliest stages of gametogenesis there is little, if any, distinction between male and female cells; that in many cases the cell boundaries are not distinct, but we have a homogeneous albumen containing scattered nuclei, recalling a *syncytium*; that these nuclei have sometimes been seen to multiply by budding or by direct division; that the nuclei, as they grow, lose their homogeneity, and differentiate a reticulum and nucleoli in their interior, and simultaneously a layer of proto-

plasm, thin at first, grows out as an envelope about them, much as in Dallinger's *monad.* (See *J. R. M. S.*, July, 1886, and Fig. 98.) When the cells are completed, they multiply by indirect division (karyokinesis), but not to a very great extent, if destined to become ova. In this case a period of growth, of storage of nutriment for the future embryo, ensues, and when this work is completed, the ovum shows its homodynamous nature with the spermatozoon by completing its delayed divisions by the formation of the *polar globules.* Why these divisions are thus delayed will be discussed in its proper place.

If the ovum has its special work to do, division of labor has also given the spermatozoon its special work. For the large and stationary ovum must be sought out and penetrated, and so the enveloping cytoplasm is built up into the proper locomotor organs, which gives the male cell its characteristic and varied forms. We see that the characters which distinguish the male from the female gamete, or *vice versa*, are purely secondary and acquired characters, and, in the absence of these, we would be unable to distinguish sex. We shall endeavor to show that *the chromatin is not sexed*, but probably differs in the two cells by an infinitesimal variation. *So far as our idea of sex implies the differentiation of* MALE *from* FEMALE, *the chromatin is not sexed, but so far as it implies* DESIRE FOR CONJUGATION *with other chromatin differing from it by a slight variation, and likewise filled with a longing for conjugation, it* (the chromatin) *is sexed, but to this idea of sex the thought of male and female is foreign. Male* and *female* are ideas that have arisen in contemplating the different secondary mechanisms that have been evolved for the purpose of effecting conjugation; and these characters are the result of the operation of the same principles that have differentiated a gland-cell from an epithelium-cell.

But, let us see how these secondary or sexual mechanisms differ, and how the nucleus is related to them. We first consider the changes that are suffered by the nucleus of

THE OVUM.

Most of the observations on the *germinal vesicle* (nucleus of the ovum) relate to its behavior in relation to the polar globules, which does not now concern us; for we now know that this is simply the nucleus dividing by karyokinesis so as to become

sexually mature, and that, as in ordinary karyokinesis, the successive halves of the nucleus left in the yelk are the homologues of those extruded in the globules. We shall show that they are all *equivalents*, and there is not a separation of "male protoplasm" from "female protoplasm" in a once "hermaphrodite" cell.

When the few observations we have of the germinal vesicle during the period of growth are compared, we are struck by the apparent variety in the different cases. But this variety is probably due in part to a real variety in nature, and in part to the limited and partial knowledge we have acquired. From a comparison of Figs. 50–64, we may gather the following general features:

1. There is a richness of chromatin development resulting in great increase in size of the nucleus.

2. There is a considerable number of nucleoli developed.

3. A large portion of the chromatin is broken down and transformed into yelk. (See Fig. 50.)

4. The boundaries of the nucleus are often broken down or obscured; if not, they remain extremely distinct, enclosing a large cavity comparatively free from chromatin, and hence the name germinal *vesicle*. But with either change we find that one of the nucleoli has taken on functions that are probably nuclear in nature, and this has given countenance to the notion that the germinal vesicle may not be a nucleus, but is a cell. Such an assumption of the nuclear functions by a chief nucleolus is repeated over and over again in gland-cells, as in Fig. 49. We thus have a chief nucleolus or *germinal dot* and one or more paranucleoli. The latter simply break down, while the former furnishes the chromatin that divides in the polar globules, and at last conjugates with the male pronucleus; so that we always have a mass of the proto-substance conserved to carry on the existence of the gemmule colony, however much of the chromatin may be used for other purposes, and this reproductive substance is always conserved in the centre of the mechanism, surrounded and protected by at least two envelopes. If the nucleus buds, it produces *paranuclei*. Perhaps this is only a peculiar method of giving off nutritive substances to the cytoplasm. We must here observe that paranuclei, wherever found, are not necessarily homologous structures, either if more than one be found in the same cell or still less where we deal with phylogenetically

widely separated cells. When the germinal dot enters upon its activities as a nucleus it passes through the stages of differentiating a reticulum and nucleoli of different kinds in itself, as we shall see under *karyokinesis.*

(*c*) THE SPERMATOZOON.

When the last division of the spermatocytes has taken place, the nucleus is practically ready for conjugation; hence, that its chromatin may meet the chromatin of the ovum, the secondary or *achromatic* structures of the nucleus transform themselves together with the cytoplasm (which seems to play a more passive part), into the suitable mechanism for effecting the transfer. In most cases the resulting form is filamentous, and has a spiral structure in some part. (See Figs. 66–93.) In such highly complex spermatozoa we may distinguish the following parts:

An outer *membrane*, which is perhaps the relic of the cell-membrane. A *head-cap*, posterior to which lies the *chromatin.* An *axial filament*, which may be taken as a sort of skeleton. (See Fig. 78, *e.*) Finally, there is a medullary sheath, best, sometimes only, developed in the "*neck*" or middle piece of the spermatozoon. This sheath is often composed of two or three bands that have been spirally twisted in opposite directions around the axial filament. Often one of the three is free and hung by a delicate mesentery, and thus may propel the spermatozoon like a screw. In the development of these parts, we first see the nucleus change its shape and become homogeneous, then the axial filament is seen stretching away from the nucleus and pushing the cytoplasm before it posteriorly as the nucleus does at the anterior end. The achromatic part of the nucleus is usually present as a paranucleus (see karyokinesis, Fig. 123, also Fig. 81), which in some cases is directly converted into the medullary sheath. Paranuclei (or granules) of a different sort are often present, and may have something to do in building the axial filament. All growth takes place in the neck just behind the head; and from this point the tail end is gradually pushed out as a completed structure. These accessory parts having accomplished their work of transferring the chromatin, which is to form the male pronucleus, are lost or dissolved in various ways. The chromatin is the essential substance, as we shall learn under "*Fertilization.*"

The development of the spermatozoa in the special cases may be

learned by a study of the figures (Plate IV.) with the accompanying explanations. We could now pass on to the subject of fertilization did we not have connected with this phenomena another series of phenomena that can be understood only by reference to the facts of "cell division," to which we next direct our attention.

(To be continued.)

DESCRIPTION OF A NEW SPECIES OF DIPODOMYS, WITH SOME ACCOUNT OF ITS HABITS.

BY F. STEPHENS.

Dipodomys deserti STEPHENS, n. s. Desert Pocket-Rat.

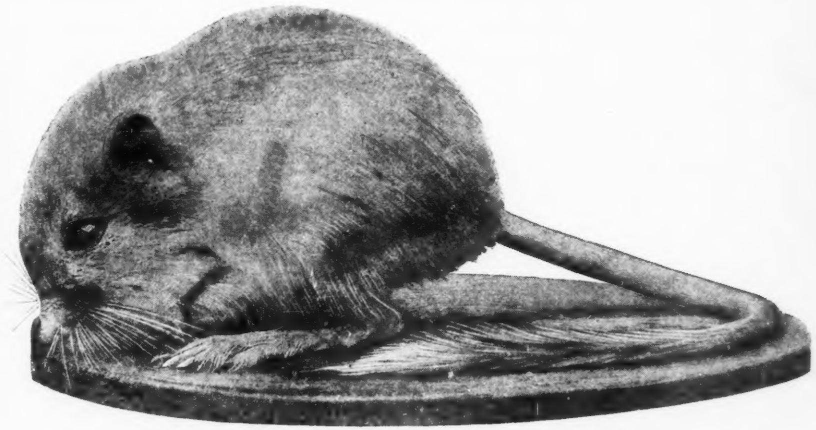
LARGEST known species of the genus. Length, head and body, 5.2 inches; tail vertebræ, 7.7 inches; hind foot, including claw, 1.9 inches. Color above pale yellowish brown, fur plumbeous at base, showing through the tips enough to give an ashy tinge. Below, white. Fore legs from elbow, and hind legs, in front, from knee, white. Tail, at base, on sides, below, and the tip, white; above, pale brown, becoming plumbeous towards the white tip. Indistinct white spot over the eye, another behind the ear, which extends across the shoulder to the white underparts. Indistinct white band across the hips. Indistinct darker spot at base of whiskers. Soles of hind feet nearly white. Type No. 314. Female, June 29, 1886. Mojave River, Cal. Deposited in the National Museum.

Habitat, Mojave and Colorado Desert regions of Southeastern California.

COMPARISON OF THE SPECIES.

Dipodomys deserti.	*Dipodomys phillipsi.*
Size large.	Size small.
Color pale, markings comparatively indistinct.	Color dark, markings distinct.
Eyes moderately large.	Eyes very large.
Soles of hind feet white in the young, indistinctly brownish in the adults, perhaps due to soiling.	Soles of feet dark brown (same color as upper surface of tail).
Spot at base of whiskers merely darker than surrounding parts.	Spot at base of whiskers nearly black.
Mastoid region enormously inflated.	Mastoid region comparatively moderately inflated.

PLATE V.



Dipodomys deserti Stephens. Desert Pocket Rat. Three-fourths natural size.
From photograph from life.

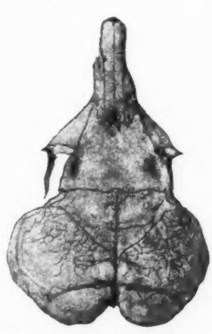


FIG. 1.—Skull of *Dipodomys deserti.*

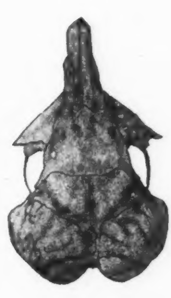


FIG. 2.—Skull of *Dipodomys phillipsi.*

Natural size.

The proportions of the two species are much the same. There are other points of difference in the skull, but this is sufficient to show their specific distinctness.

D. phillipsi ordi, being a slightly larger, rufous-tinged variety of *D. phillipsi*, may be considered as being classed with the latter in the above comparison.

The type specimen may be below the average size. I have a male that measured (fresh) 5.8 inches head and body, 8.2 inches tail vertebræ. Total number of specimens examined is nine. The photographs of skulls are natural size; of the animal, three-fourths natural size.

The last three days of June, 1886, I camped near the Mojave River on my way home from a collecting trip along the desert side of the San Bernardino Mountains. The first morning there (June 29) I found two peculiar *Dipodomys* in traps I had set the previous evening. They seemed to be a pale variety of *D. phillipsi*, such as I knew to be liable to occur there, it being the rule that most birds and mammals inhabiting the Mojave and Colorado Deserts are paler in color than others of the same species found in the moister coast region. In another trap was an ungrown *D. phillipsi* of nearly normal color, but I laid its darker color to its evident immature condition. At sunset I again put out my traps, and, as there were more inhabited burrows than I had traps for, I put out poisoned wheat also, which proved a most unwise act. This poisoned wheat is widely used in California to destroy ground-squirrels, pocket-rats, and similar pests. When it is used, some of the poisoned animals come to the surface to die, and I expected to obtain some additional specimens by its use. The next morning I had one *D. phillipsi* and two of the pale variety in my traps, and I found one of each phase of coloration poisoned, and, later in the day, when the hot sun had spoiled it, I found another pale one. Nearly all the poisoned wheat had been taken. These additional specimens convinced me that the pale animals were a good species.

I had intended driving on in the afternoon, but I concluded to stop another night to try for more. The poisoned wheat had done its work only too well, for my traps contained no pocket-rats the next morning, and but few burrows showed signs of occupancy. I was unable to revisit the region until the next November, when I followed the Mojave River for twenty-five

miles from where it leaves the mountains, but succeeded in finding no more colonies, though several miners whom I met knew the animal, and thought they were not rare. From the colony found in June I obtained three *D. phillipsi* and three more of the new species, which I have named *Dipodomys deserti.* As the river was now dry in this part of its course, I was able to spend but two nights at the place. The colony appeared to be nearly deserted, but I do not think I obtained them all. I brought two animals of each species home alive, and still have them in captivity. On my way home I camped one night in the Cajon Pass, at an altitude of about three thousand five hundred feet. The night was very cold for this region, ice forming in my canteen and coffee-pot. The *D. deserti* suffered badly. I had not expected so severe a night, and had given them no protection more than to turn the open side of the box (which was covered with wire netting) to another box. At sunrise I noticed that one of the *D. deserti* seemed uneasy, and a closer inspection showed that its tail was frozen as stiff as a stick. In turning about in its narrow quarters it had broken off about two inches of the tail, the piece lying on the floor. The other *D. deserti* had not suffered so much, but it ultimately lost most of the terminal white tuft. The *D. phillipsi* seemed none the worse for the frost, and probably are a hardier race, which may account for their wider distribution.

The following notes on habits are based mainly on observations of my captives. The *D. deserti* especially have become very interesting pets, and allow handling freely. I often turn them loose in a room of my house, usually but one at a time, as they are somewhat quarrelsome, especially the one with the frosted tail, the accident having made it somewhat bad-tempered. It is quite pugnacious, driving the others about so that they often return to their cages. The *D. phillipsi* do not pay much attention to the peaceable *D. deserti*, but when the other comes near they promptly leap away. When the two species were first turned loose together they had an all-round fight, but the riot did not last long, the heavier *D. deserti* being easily victorious. The actions of both species in fighting are much alike. When both are disposed to stand their ground they stand nearly erect, facing one another, and apparently cuff and scratch with the fore feet, the motions being too quick to follow accurately with

the eye. A few passes and one or the other loses its balance and leaps away, followed a short distance by the other. I have been unable to detect any use of the teeth in such face-to-face encounters. Sometimes the larger *D. deserti* will happen near one of the others and slowly and slyly work closer, and suddenly pounce on the other, when I have heard a squeak of pain as if the teeth had been used. The bite cannot be severe, for the mouth is not capable of opening widely, and the upper incisors slope inward so much that they can get but a shallow hold. I have not handled the *D. phillipsi* much, but they have never bitten me. I handle the *D. deserti* often; one has never bitten me, the other but once, when I attempted to hold it against its wishes. It bit the inside of my forefinger where the skin was thick, and though the teeth met, but a drop or two of blood flowed. The punctures made by the upper and under incisors were but five-thirty-seconds of an inch apart, and I believe it was about as hard a bite as the beast was able to inflict on so comparatively flat a surface. Of course they are capable of cutting a twig or similar hard substance of small size. They have not so far attempted to bite the tail of another, which is the favorite mode of attack of their relatives, the tuft-tailed pocket-mice (*Perognathus penicillatus*). Locomotion is similar with both species, but *D. phillipsi* is more agile, leaping farther and quicker. This species can reach to about eighteen inches from the floor in trying to escape from the room, the leap taking place from near the foot of the wall. I think the usual horizontal leap when running rapidly is three feet or more, which is considerably more than that of *D. deserti*. The gait might be termed a hop, the work being mostly done with the hinder limbs. When moving about slowly, the first movement seems to be a tap on the ground with the fore feet to raise the fore part of the body to a leaping position, when the powerful hinder limbs give a spring resulting in a leap of a few inches. When they are running rapidly one cannot see just how it is done, but I often thought that the fore limbs take little or no part in the action, which seems to be aided by the long tail, both in guiding and balancing. It certainly looks as if the animal would be in danger of running its nose in the ground and "ending over" if it depended on its very short fore legs to raise its body into leaping position after each quick leap, for *D. phillipsi* at least can get over the ground at a pace that would put a cat

to nearly its best speed to overtake it. I once saw a *D. phillipsi* run some forty or fifty yards in broad daylight, and have often seen them skurry away from camp in the moonlight when I happened to alarm them by some movement.

In places where much camping is done, such as by springs on the principal roads from one mining camp to another, the pocket-rats are in the habit of coming about the wagons at night to pick up the grain scattered by the horses, etc., becoming comparatively tame, as no one harms them. I never knew a dog to catch one, for they can get under way very quickly, and in such places they have many holes, perhaps for such emergencies, and they immediately vanish in the nearest. In feeding they often rise to a more or less erect posture, apparently to get a better view of their surroundings. In the house I have seen them stand erect on the tail and the toes of the hind feet, thus forming a secure tripod; at such times they walk about several steps, sidewise as well as forward, with as much ease as a man.

D. phillipsi is the shyest; they dislike to be handled, and do not often come near me when out in the room. *D. deserti* does not seem to dislike handling, but they will not yet come to me when called, though when running about the room they pay no attention to me, running across my feet, etc. Sometimes when I come in the room they will presently come quite close to me, apparently from a mild curiosity to see what I am doing. They appear to be almost devoid of fear of other animals. The first time I put the cat in the room they came to the front, putting their noses against the wire netting to look at the cat, which was greatly vexed that she could not get at them. In this instance the *D. phillipsi* remained at the back of their cages.

So far none of my captives will drink water. They will eat of vegetables, such as sweet potatoes, the leaves of beets and cabbages. It is probable that they obtain sufficient moisture from such sources. The principal food seems to be seed and grain. They consume but little more than a heaping tablespoonful each of wheat or barley in twenty-four hours, and one or two square inches of beet or cabbage leaves, so they are not heavy eaters. For the first two or three days I had them they probably ate double this amount, but as they had been on short allowance for some weeks they were more than usually hungry. The seeds on which they depend in a state of nature had been

ripe some months and naturally were pretty well gathered in, but this colony had depended considerably on the waste of the travellers who usually camped in the immediate vicinity. The travel had ceased in July when the stream dried up, and thus compelled the use of a longer route until the winter rains should start the stream running again. This hunger may have caused them to tame quicker. I heard the trap-door fall when the first one was caught, and immediately took it out and put it in a cage and gave it grain. It was amusing to see the eagerness with which it immediately went to filling its pockets. It stuffed them so full that it must have been positively painful, and then it would not stop to eat, but hunted about for some exit; not finding one, it ejected the contents of its pockets in a corner out of the firelight and went back for more. This time it ate a little, but soon gathered the remainder and deposited it with the first. After eating a little more, it refilled its pockets and hunted about for a better place to make a *cache*, seeming to think its first choice insecure. These actions plainly show that they are in the habit of storing away their surplus. In grain-fields infested by *D. phillipsi*, the plough will often turn up a deposit of a pint or so when the field is ploughed for re-seeding. The loss to farmers is thus quite considerable at times.

Having watched them repeatedly, I can say positively that the pockets are filled with the fore feet used as hands. When placed at a pile of grain, when hungry, they fill the pockets very quickly, both pockets being filled alike. The two pockets of *D. deserti* will hold a heaping tablespoonful of grain, and are, therefore, capable of carrying nearly a full day's supplies. The filling is done so rapidly that, where a hard grain like wheat is used, a continuous rattling sound is made. The ejecting of the grain from the pockets is aided by a forward, squeezing motion of the fore feet, each foot making two or three quick forward passes occupying scarcely a second of time. For the first few days all grain put in the cages was immediately pocketed, but since then they rarely fill their pockets, seeming to have found its uselessness.

The position at rest is a curious one. At first the animal stands on all four feet, with the entire sole of the hind feet resting on the ground, some of the weight coming on the fore feet; presently the hind feet will hitch forward until the centre of the

hind feet comes under the centre of gravity, thus taking all the weight; then, often, the fore part of the body will be slightly raised and the fore feet drawn up against the body. If disposed to sleep, the bright eyes will slowly close, the fore feet droop until touching the ground, the nose slowly comes down and backward until resting between the toes of the hind feet, and the now sleeping animal is nearly as round as a ball. This appears to be the common sleeping posture. If there be room, the tail will be extended back nearly in a straight line, but in cramped quarters it will be curved to one side or even alongside the body; but in either case the basal part will be curved back enough to give some support. These animals make much use of the tail, and its loss would be a great inconvenience. When one of my *D. deserti* lost the use of its tail temporarily through its being frozen, I saw it fall over several times, lacking its accustomed support.

I do not see them make much use of the power of scent, but the long whiskers are very sensitive, and must be of much use in their nocturnal rambles. The sight is good in daylight, though they do not like a strong light. If compelled to rest in a light place, they face away from the light if possible. Both species of *Dipodomys* seldom emerge from their burrows until the evening light gets dim. The hearing does not seem to be unusually acute, but I have made no experiments yet to positively determine the fact.

Phillips's pocket-rat does not seem to live in companies, though the holes of different individuals may be but a few yards apart. From such information as I can gather, and from what I have seen myself, I think that the desert pocket-rat lives in colonies often if not usually. The only place where I have taken *D. deserti* has a colony of several groups of holes, each group being from two to eight entrances to a set of intercommunicating galleries, from six to thirty inches below the surface, and being within a space of two to three yards square. None that I opened proved to be inhabited. In each several galleries terminated one to two feet from the surface in a slight enlargement, which generally contained the hulls of barley, etc., as if they were used as places of storage. Two contained a little dry grass, as if they had been used as nests. I put paper and cotton in the cages, but the *D. deserti* made but little use of it. The *D. phillipsi*,

however, made a rude nest of theirs. After I had the animals a few days I gave them a little dry earth. The *D. deserti*, especially, were pleased with it, rolling in it, pushing along on their bellies, and enjoying a good dust-bath. They looked much better for it, the pelage, which had been rough, becoming smooth and glossy.

I think they must sometimes eat insects, as I saw one, when hopping about the floor, come across a cricket, which it appeared to leap upon, and, as I could find nothing more of the cricket, I think the pocket-rat must have eaten it.

None of the females that I obtained contained embryos, but I have a skin of a *D. deserti* some four or five weeks old, killed with a whip by a teamster near Seven Palms, on the Colorado Desert, April 1, 1886. A friend has two young *D. phillipsi* in alcohol, taken in October, which were some five or six weeks old when taken.

I think *D. deserti* will prove to be commonly distributed over most of the Mojave and Colorado Deserts west of the Colorado River, and possibly they may occur in Arizona and Mexico.

HISTORY OF GARDEN VEGETABLES.

BY E. LEWIS STURTEVANT, A.M., M.D.[1]

THIS series of articles, which should be rather entitled notes on than history of cultivated vegetables, is intended as a portion of a study into the extent of variation that has been produced in plants through cultivation. The author has had the great advantage of opportunity of studying the growing specimens in nearly all the species named, and in nearly all the varieties now known to our seed trade; and this study has given him confidence in the establishing of synonymy, as oftentimes the variables within types have furnished clues of importance. The treatment, as a matter of convenience, is arranged alphabetically, and includes the species recognized by Vilmorin-Andrieux in their standard work "Les Plantes Potagères," 1883, and the English edition "The Vegetable Garden," 1885, with the exception of the

[1] Director of the New York Agricultural Experiment Station, Geneva.

Pineapple and Strawberry, species which by American gardeners are included among fruits. In the matter of references the citations are all taken directly from the sources indicated, quoted references being in all cases so acknowledged in the notes. In a work of this character, where the conclusions can oftentimes seem questionable, it is important that facilities for corroboration should be freely offered, hence I have made my references to editions and pages.

AFRICAN VALERIAN. *Valeriana cornucopiæ* L.

The African valerian is a recent introduction to gardens, and furnishes in its leaves salad of excellent quality. The plant is native to the Mediterranean region, in grain-fields in waste places. C. Bauhin,[1] in 1596, speaks of it as if of recent introduction to botanical gardens in his time, and Clusius,[2] in 1601, J. Bauhin,[3] in 1651, and Ray,[4] in 1686, all describe it.

It is not spoken of as under cultivation in Miller's Dictionary, 1807, nor does Don in his "Gardeners' Dictionary," 1834, speak of any use, although he is usually very ready with such information. In 1841 the "Bon Jardinier" in France refers to it as being a good salad plant. As neither Noisette,[5] 1830, nor Petit,[6] 1826, nor Pirolle,[7] 1824, mention it, we may assume that it had not entered the vegetable garden at these dates. In 1863, Burr[8] describes it among American garden vegetables, as does Vilmorin[9] in France in 1883, and in England in 1885.

No varieties are described, although a purple- and a white-flowered form are mentioned by Bauhin as occurring in the wild plant. The one sort now described has pink- or rose-colored flowers.

The vernacular names, as given by Vilmorin, are: English, *African Valerian;* French, *Valériane d'Alger, Corne d'abondance;* German, *Algerischer Baldrian;* Flemish, *Speenkruid;* Dutch, *Speerkruid.*

[1] Bauhin, Phytopin., 1596, 293; Pin., 1623, 164; Prod., 1671, 87.
[2] Clusius, Hist., 1601, 2, 54.
[3] J. Bauhin, Hist., 1651, iii. pt. 2, 212.
[4] Ray, Hist., 1686, 394.
[5] Noisette, Man. du Jardinier, 1830.
[6] Petit, Dict. du Jard., 1826.
[7] Pirolle, L'Hort. Français, 1824-25.
[8] Burr, Field and Gard. Veg., 1863, 401.
[9] Vilmorin, Les Pl. Pot., 1883, 562; The Veg. Gard., 1885, 593.

The synonymy is as below:

Valeriana peregrina purpurea. Bauh., Phytopin., 1596, 293.

Valeriana indica. Clus., Hist., 1601, 2, 54, *cum ic.*

Valeriana peregrina purpurea albave. Bauh., Pin., 1623, 164; Prod., 1671, 87, *cum ic.*

Valeriana peregrina, seu Indica. J. Bauh., Hist., 1651, iii. pt. 2, 212, *cum ic.*

Valeriana mexicana. Ray, Hist., 1686, i. 394.

Valerianella cornucopioides, flore galeato. Tourn., Inst., 1719, 133.

Valeriana cornucopiæ. Linn., Sp., 1762, 44.

Fedia cornucopiæ. Gaertn., Fruct., 1788, ii. 37.

ALEXANDERS. *Smyrnium olusatrum* L.

The name said to be a corruption of Olusatrum (Webster's Dict.), but Ray ("Hist. Plant.," 437) says called so either because it came from the Egyptian city of that name, or it was so believed. The Italian name *macerone* is believed by Ray to have been corruptly derived from Macedonia, but a more probable origin is from *maceria*, the Italian for wall, as Columella (lib. xi. c. 3) says, "Pastinato loco semine debet conseri maxime juxta *maceriam*."

English, *Alexanders, Alisanders, Allisanders, Horse parsley, Macedonicum, Parsley macedonian.* Arabic, *Seniruion.* Belgian, *Petersilie van Alexandria, P. van Macedonien, Groot petersilie.* French, *Alexandre, Ache large, Grand ache, Maceron.* German, *Alexandrinum, Brust-wurzel, Engel-wurzel, Herba alexandriana, Gross Epffich, Peterlin, Liebstockel.* Greece, *Agrioselinon, Mauroselinon, Skuloselinon.* Greek, *Hipposelinon, Smyrnion.* Italian, *Alessandrion, Herba Alexandrina, Macerone, Smirnio.* Latin, *Hipposelinon, Olisatum, Olusatrum, Smyrnion.* Portuguese, *Cardo do coalho.* Spanish, *Apio macedonica, Perexil macedonico.*

In this Umbellifer, as De Candolle remarks, we can follow the plant from the beginning to the end of its culture. Theophrastus, who flourished about 322 B.C., speaks of it as an officinal plant, under the name of Hipposelinon. Dioscorides, who lived in the first century after Christ, speaks of the edible properties of the roots and leaves, while Columella and Pliny, authors of the same century, speak of its cultivation; Galen, in the second century, classes it among edibles, and Apicius, in the third century, gives a receipt for its preparation for the table. Charle-

magne, who died A.D. 814, included this vegetable among those ordered to be planted on his estates. Ruellius's edition of Dioscorides, 1529, does not speak of its culture, nor does Leonicenus, 1529 (not necessitated by the text); but Fuchsius, 1542, says planted in gardens. Tragus, 1552, received seed from a friend, so it was apparently not generally grown in his part of Germany at this date. Matthiolus, in his "Commentaries," 1558, refers to its edible qualities. Pena and Lobel, 1570, say in England it occurs abundantly in gardens,—"in hortis copiosissimum, ubi radix illi crassior, magis succosa, vesca et tenerior, quam suapte sponte nato," and the cultivated form far better than in the wild plant. Camerarius, "Epitome," 1586, says, "in hortis seritur." Gerarde, in 1597, does not speak of its culture, but says, "groweth in most places of England," but in his edition of 1630 says, "the root hereof is also in our age served to the table raw for a sallade herbe." Dodonæus, 1616, refers to its culture in the gardens of Belgium, and Bodæus a Stapel, in his edition of "Theophrastus," 1644, says is much approved in salads, and is cultivated as a vegetable,—"Contra maceronis esui idonea, palato non ingrata; quo nomine a Gallis, Anglio, Germanis avidissime in acetariis expetitur ac ab olitoribus sedulo colitur;" yet, in 1612, "Le Jardinier Solitaire" mentions the culture of celery, but not of Alexanders, in French gardens. Quintyne, in the English edition of his "Complete Gard'ner," 1704, says "it is one of the furnitures of our winter-sallads, which must be whitened like our wild Endive or Succory." In 1726, Townsend, in his "Complete Seedsman," refers to the manner of use, but adds, "'tis but in few gardens." Mawe's "Gardener," 1778, refers to this vegetable, but it is apparently in minor use at this time; yet Varlo, in his "Husbandry," 1785, gives directions for continuous sowing of the seed in order to secure a more continuous supply. McMahon, in his "American Gardeners' Kalendar," 1806, includes this vegetable in his descriptions, but not in his general list of kitchen-garden esculents, and it is likewise enumerated by later American writers, and is included by Burr, 1863, among garden vegetables, —a survival of mention apparently not indicating use; and Vilmorin, in his "Les Plantes Potagères," 1883, gives a heading and a few lines to *maceron*, but I do not now find its seed advertised in our catalogues, and I never remember to have seen the plant or heard of its being in use in my time.

Smyrnium perfoliatum L.

This species is perhaps confounded with *S. olusatrum* in some of the references already given. Loudon says it was formerly cultivated, and McIntosh says it is thought by many superior to *S. olusatrum*,—a remark which Burr ("Field and Garden Vegetables") includes in his description. Although the species is separated by a number of the older botanists, yet Ruellius, 1529, is the only one I find who refers to its edible qualities.

This plant, which De Candolle says has been under common culture for fifteen centuries ("a été une des plus communes dans les jardins pendant environ quinze siècles," "Orig. des Pl. Cult.," 72), has shown, so far as my researches indicate, no change of type under culture. The figures which occur in so many of the herbals all show the same type of plant, irrespective of the source from which the illustration may have been taken, unless perhaps the root is drawn rather more enlarged in some cases than in others.

ALKEKENGI. *Physalis* sp.

The alkekengi, usually known in our seed catalogues by the name of Strawberry Tomato, is classed with the Tomatoes, and it is worthy of note that Hernandez, in his work on Mexican plants, published in 1651, did the same. There are a number of species which occur under the general name, and the plant is frequently found in gardens, as some people are fond of the fruit, whether raw or preserved. The plant most often, however, occupies waste places, springing up spontaneously after being once introduced, and its products are of very minor importance among vegetables.

Among the species that have been identified from the seeds of the "Strawberry Tomato," obtained from commercial sources, are the following:

1. *Physalis angulata* L.

This species is found widely dispersed over tropical regions, extending to the southern portion of the United States and to Japan. It is first described by Camerarius,[1] in 1588, as a plant hitherto unknown, and an excellent figure is given. It was seen in a garden by C. Bauhin[2] before 1596, and is figured in the

[1] Camerarius, Hort. Med., 1588, 70, Fig. 17.
[2] Bauhin, Phytopin., 1596, 297.

"Hortus Eystettensis,"[1] 1613. J. Bauhin[2] speaks of its presence in certain gardens in Europe. Linnæus makes a variety with entire leaves, and both his species and variety are figured by Dillenius,[3] who obtained the variety from Holland in 1732. When it first appeared in our vegetable gardens I do not find recorded.

Its synonymy seems to be as below:

Halicacabum sive Solanum Indicum. Cam., Hort., 1588, 70 *cum ic.*

Solanum vesicarium Indicum. Bauh., Phytopin., 1596, 297; Pin., 1623, 166; Ray, Hist., 1686, 681.

Halicacabum seu Solanum Indicum. Camer., Hort. Eyst., 1613, *cum ic.*

Solanum sive Halicabum Indicum. J. Bauh., 1651, iii. 609, *cum ic.*

Alkekengi Indicum majus. Tourn. Inst., 1719, 151.

Pops. Hughes, Barb., 1750, 161.

Physalis angulata L. Gray, Syn. Fl., ii. pt. i. p. 234.

2. *Physalis barbadensis* Jacq.

This species is said by Vilmorin to be sometimes cultivated in France. According to Maycock[4] it is the Pop-vine of Hughes.[5] I have not seen it growing.

3. *Physalis lanceolata* Michx.

This species was among the "Strawberry Tomatoes" grown in 1886, and occurred in two varieties,—*a*, the ordinary sort, and *b*, with broader leaves and more robust growth. Its habitat is given by Gray as from Lake Winnipeg to Florida and Texas, Colorado, Utah, and New Mexico.

4. *Physalis peruviana* L.

This South American species seems to have become fairly well distributed through cultivation. Birdwood[6] records it as cultivated widely in India, and gives native names in the various

[1] Hortus Eystet., 1613 (also 1713). Æst. ord., 13, fol. 2.

[2] Bauhin, Hist., 1651, iii. 609.

[3] Dillenius, Hort. Elth., 1774, p. 14, f. 12, t. 12; p. 12, f. 11, t. 11.

[4] Maycock, Fl. Barb., 98.

[5] Hughes, Barb., 161.

[6] Birdwood, Veg. Prod. of Bomb., 173.

dialects, and Speede[1] mentions it also. In France it is classed among garden vegetables by Vilmorin.[2] Descourtliz gives a Carib name, "*sousourou-scurou.*" Drummond,[3] who introduced the plant into Australia, after ten years reports it as completely naturalized in his region. This species differs but slightly from *P. pubescens.*[4] Gray,[5] in 1878, says it was introduced into cultivation several years ago, but has now mainly disappeared.

In English called *Cape Gooseberry*[6] or *Cherry Tomato;* in Carib, "*sousourou-scurou;* in Tagalo, "*potocan;*" in India, *Winter Cherry, Turparee;*[7] in Bengali, *Tapureca, Tapeeriya,* and *Tophlee;* in Hindustani, *Macao;* in Telinga, *Budda-busara, Pambudda.*[8]

5. *Physalis philadelphica* Lam.

Although the habitat of this species is given by Gray[9] as in fertile soil, Pennsylvania to Illinois and Texas, yet it seems to be the Miltomatl figured by Hernandez[10] in his Mexican history, published in 1651. It is described by Burr[11] under the name *Purple Ground Cherry, Purple Strawberry Tomato, Purple Winter Cherry.* The "*petite tomate du Mexique,*" as received from Vilmorin, in 1883, can be assigned to this species, as can also a "Strawberry Tomato" grown in 1885.

6. *Physalis pubescens* L.

This species has a wide range, extending from New York to Iowa, Florida, and westward, from Texas to the borders of California, and southward to tropical America. It is described by Marcgrav[12] and Piso[13] in Brazil about the middle of the seventeenth century, and Feuille,[14] 1725, mentions it as cultivated and wild in

1 Speede, Ind. Handb. of Gard., 1842, 233.
2 Vilmorin, Les Pl. Pot., 1883, 4.
3 Drummond, Hook. Jour. of Bot., 1840, ii. 347.
4 Vilmorin, Les Pl. Pot., 4.
5 Gray, Syn. Flora of N. Am., ii. pt. 1, p. 233.
6 Pickering, Ch. Hist. of Pl., 755.
7 Speede, l. c.
8 Birdwood, l. c.
9 Gray, Syn. Fl., l. c.
10 Hernandez, Nova Hist. Mex., 1651, 295.
11 Burr, Field and Gar. Veg., 1863, 593.
12 Marcgravius in Piso, Brazil, 1648, 12.
13 Piso, de Ind., 1658, 223.
14 Feuille, Obs., 1725, iii. p. 5, pl. 1.

Peru. It has been introduced into many regions. Loureiro[1] records it in Cochinchina, Bojer,[2] as cultivated in the Mauritius and in all the tropical countries, and it also occurs in the descriptions of garden vegetables in France and America. It was cultivated by Miller in England in 1739,[3] but was described by Parkinson in 1640. It had not reached the kitchen garden in 1807, but had before 1863.

Its synonymy seems as below given :

Camaru. Marcg., 1648, 12 ; Piso, 1658, 223.

Halicacabum sive Alkakengi Virginense. Ray, 1686, 681.

Alkekengi Virginianum, fructu luteo. Tourn., 1719, 151.

Alkekengi Virginianum, fructu luteo, vulgo Capuli. Feuille, 1725, iii. 5.

Alkekengi Barbadense nanum, Alliariæ folio. Dill. Elth., p. 10, f. 9, t. 9, 1774.

Physalis pubescens. Lin., Sp., 1762, 262.

7. *Physalis virginiana* Mill.

This species has also been grown from the seedsmen's "Strawberry Tomato." It is low spreading. Its habitat is given by Gray as Upper Canada to Florida and Texas.

The number of species which are included in the common name Strawberry Tomato is indicative of the wide source of seed-supply tributary to our seed-houses, as well as to the little importance of the plant for the vegetable garden. It is quite evident that in nature many of these species are quite variable, furnishing numerous botanical varieties. Whether any varieties have originated under culture it is scarcely worth the while to consider, as the common nomenclature is so obscuring, and as there is no indication of the plants receiving enough consideration to justify us in supposing attempts for improving through selection or careful cultivation.

American Cress. *Barbarea præcox* R. Br.

The vernacular name is a misnomer, as this species, although introduced into America, is not native, but an inhabitant of the

[1] Loureiro, Fl. Cochinch., 1790, 133. [2] Bojer, Hort. Maurit., 1837, 237.
[3] Miller's Dict., 1807.

Old World. The first mention we find is that of Ray,[1] who notices it in his description of the similar species *Barbarea vulgaris.* It is cultivated in the Mauritius,[2] in gardens of England[3] as a cress in 1855, and stated by Don,[4] in 1831, to be generally liked as a winter cress in Germany and England. In France it is included among garden vegetables by Vilmorin[5] in 1883, but not by Noisette[6] in 1829. It is recorded for American gardens by Burr[7] in 1863, and Gray,[8] in 1880, says it is cultivated from Pennsylvania southward as a winter cress.

It is known in the Southern States under the name of *Early Winter Cress,* or *Scurvy-grass,*[9] in English generally *Winter Cress, American Winter Cress,* and *Belle Isle Cress,* or *American Cress;*[10] in France[11] as *Cresson de terre, Cresson de jardin, Cresson vivace, Cresson des vignes, Cressonette de jardin, Roquette,* and *Sisymbrium;* in German, *Amerikanische Winterkresse;* in Flanders, *Wilde kers;* in Denmark, *Winter karse.*

ANGELICA. *Angelica archangelica* L.

This species is occasionally cultivated among aromatic or medicinal herbs. Its young, tender stalk in May, cut into small pieces, makes an admirable sweetmeat, and in the north of Europe the Laplanders consume its green shoots as a salad. The medicinal properties of the root were highly prized in the Middle Ages. In Pomet[12] we read that the seed is much used to make angelica comfits, as well as the root for medicine. Bryant[13] deems it the best aromatic that Europe produces.

This plant must be a native of Northern Europe, for I find no references to it in the ancient authors of Greece and Rome, nor is it mentioned by Albertus Magnus in the thirteenth century. By Fuchsius, 1542, and succeeding authors it receives proper attention, and is recorded as cultivated in gardens.

[1] Ray, Hist., 1686, i. 809, sub spec., 8.
[2] Bojer, Hort. Maur., 1837, 10.
[3] McIntosh, Book of the Gard., 1855, ii. 170.
[4] Don, Gard. Dic., 1831.
[5] Vilmorin, Les Pl. Pot., 1883, 197.
[6] Noisette, Man. du Jard., 1829.
[7] Burr, Field and Gard. Veg., 1863, 403.
[8] Gray, Field, Forest, and Gard. Bot., 1880, 54.
[9] Gray, l. c. [10] Burr, l. c. [11] Vilmorin, l. c.
[12] Pomet, Hist. of Drugs, 4th ed., 1748, 42.
[13] Bryant, Fl. Diet., 1783, 53.

The German name *Heilige Geist Wurz* implies the estimation in which it was held, and offers clue to the origin of the word *Angelica*, or angel plant, which occurs in so many languages, as in English, Spanish, Portuguese, and Italian, becoming *Angelique* and *Archangelique* in French, and *Angelickwurz* in German. Other names, of like import, are the modern *Engelwurz* in Germany, *Engelkruid* in Flanders, and *Engelwortel* in Holland.

The various figures given by herbalists show the same type of plant, the principal differences to be noted being in the size of the root. Pena and Lobel,[1] in 1570, note a smaller variety as cultivated in England, Belgium, and France, and Gesner is quoted by Camerarius[2] as having seen roots of three pounds' weight. Bauhin,[3] 1623, says the roots vary, the Swiss-grown being thick, those of Bohemia smaller and blacker.

ANISE. *Pimpinella Anisum* L.

Anison was known to the ancient Greeks, and Dioscorides says the best came from Crete, the next best from Egypt; and it is mentioned by Theophrastus.[4] Pliny,[5] in the first century, says "*anesum*, green or dry, is desirable in all seasonings or sauces," and the seeds are even sprinkled in the under crust of bread, and used for flavoring wine. He quotes Pythagoras as praising it whether raw or cooked. Palladius,[6] in the beginning of the third century, gives directions for its sowing. Charlemagne,[7] in the ninth century (A.D. 812), commanded that anise should be sown on the imperial farms in Germany. It is mentioned also by Albertus Magnus[8] in the thirteenth century. It seems to have been grown in England as a pot-herb prior to 1542, as Boorde,[9] in his "Dyetary of Helth," printed in that year, says of it and fennel, "These herbes be seldom used, but theyr seedes be greatly occupyde." Ruellius[10] records it in France in 1536, and gives the

[1] Pena and Lobel, Adversaria, 1570, 311.
[2] Camerarius, Hort., 1588, 16.
[3] Bauhin, Pin., 1623, 155.
[4] Bodæus a Stapel, Theop., 1644, 744.
[5] Pliny, lib. xx. c. 72.
[6] Palladius, lib. iii. c. 24; lib. iv. c. 9.
[7] Quoted in Pharmacographia, p. 310.
[8] Albertus Magnus, De Veg., Jessen ed., 1867, 476.
[9] Quoted in Pharmacographia, 311.
[10] Ruellius, De Stirp., 1536, 701.

common name as *Roman fennel*, the same as Albertus Magnus used in the thirteenth century. It is classed among culinary herbs by Laurembergius[1] in 1632, and in America by McMahon[2] in 1806.

In the seventeenth century Quintyne[3] records the use of the leaves in salads. The seeds now serve to flavor various liqueurs; in Italy they appear in diverse pastries; in Germany they are put into bread; in England, in special bread, in rye bread, and even in cheese.[4] In Malta, localities in Spain, France, Southern Italy, Germany, and Russia the plant is grown on a large scale for the seed, which enters commerce for use in flavoring medicines, etc. It is also grown in Northern India and Chili.

The plant is indigenous to Asia Minor, the Greek islands, and Egypt, but is nowhere to be met with undoubtedly growing wild; and I have found no indication of its having formed varieties under cultivation, except that Bauhin records one sort having rounder and smaller seeds than the common.

(To be continued.)

EDITORS' TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

In all of our four hundred colleges and universities, with a dozen conspicuous exceptions, the instruction in the biological sciences is but little more than a farce. College presidents and trustees seem to think that while some special knowledge is necessary for teaching the classics and mathematics, any one is competent to give instruction in botany and zoology. Indeed, it would even appear that they regard eminence as an investigator in either of these branches as an undesirable feature in an instructor. The teachers of biology are mostly men without biological training, men whose ideas and methods are those of a generation ago, and who have no more idea of modern science and modern scientific thought than have the poorest of the pupils who are unfortunate enough to come under them. Their whole idea of botany is "analysis," while zoology is but

[1] Laurembergius, Hort., 1632, 193.
[2] McMahon, Am. Gard. Kal., 1806.
[3] Quintyne, Complete Gard., 1693.
[4] Joigneaux, Traité des Graines, 146.

cut-and-dried classification. This is true not only of most Western institutions, but of many in the East as well. It was in one of the latter that the students of zoology were treated to three solid months of worms, while, for aught the professor said, they were left in absolute ignorance of the existence of the groups of protozoa and vertebrates. Too frequently ministers and lawyers are installed as professors of natural history. Neither have had the training necessary to fit them for the position, but they are graduates of the college, and must be taken care of. Those in authority do not seem to realize that the professional studies of a clergyman, instead of fitting one for a student of nature, are a positive hindrance. The whole theological training lies in the lines of faith and reverence for authority, while science demands of its devotees, if not a sceptical spirit, one of complete independence. One cannot rely upon any statement solely on the grounds that it is advanced by a Cuvier or an Agassiz. Science has no infallible gospel wherewith to settle all disputes except that presented by the book of nature, and how difficult this is of interpretation only the original investigator knows. The lawyer or the clergyman, when he enters the field of science, brings his traditions and his old methods of thought with him. He looks for the written accounts as he formerly turned to his Bible or his "Blackstone," and when he finds any statement in print, he pins his faith to it as unquestionably as he did to the other authorities in the days of yore.

Were this selection of incompetent instructors a matter of necessity it would not speak well for American science; but it is not. We have in our country an abundance of able students, but, strange to say, it is the exception, rather than the rule, to find our best workers occupying professors' chairs. This results not from any disinclination for teaching on the part of these students, but from the stupidity of our college officers, who, if offered the choice between excellence and mediocrity, almost invariably choose the latter.

When the Society of American Naturalists was formed, one of the objects proposed was a reform in this respect; but so far nothing has been accomplished in this direction. How to proceed in changing this state of affairs may be a question, but it is to be hoped that in the early future some steps may be taken which will tend to improve the character of instructors and in-

struction. A list of eligible persons, with accounts of their work, etc., might be prepared and placed in the hands of a committee, so that those in search of a professor might know from whom to select, while a few protests sent to college trustees, on making an eminently unfit nomination, might bear some good fruit.

GENERAL NOTES.

GEOGRAPHY AND TRAVELS.[1]

America. ALASKA.—On his way to Mount St. Elias, Lieutenant Schwatka crossed an unknown river, which, at eight miles from its mouth, is said to be a mile in width, and to flow at a rate of ten miles an hour. It was named Jones River. A glacier twenty miles wide was seen by the explorers. It extended fifty miles along the base of the St. Elias Alps, and was named the Agassiz Glacier. Another to the west was called the Guyot Glacier, while a third was named in honor of Professor Tyndall. They then ascended Mount St. Elias to a height of seven thousand two hundred feet above the snow-line. Glaciers were seen rising, sometimes perpendicularly, to heights varying from three hundred to three thousand feet, and enormous crevasses were frequent. Three peaks, varying from eight thousand to twelve thousand feet, were seen, and named Cleveland, Whitney, and Nicholls.

THE SOURCE OF THE MISSISSIPPI.—The controversy concerning Lake Glazier has been a long one. *Science* (August 13) prints a letter by Russell Hinman, giving copies of Schoolcraft's map, and those of Nicollet, 1843; the Land Office, 1879; and Glazier, 188[illegible]. He also gives, in parallel columns, the language used by Schoolcraft (1832) and that of Glazier (1881). Nicollet's map shows three small lakes in the position of Glazier's single one. The similarity of the words has, of course, no weight as evidence concerning a geographical fact, though it may be explained by facts occurring in similar order. Pearce Giles (*Science*, September 24) endeavors to prove that the lakelets or ponds on Nicollet's map have nothing to do with the source of the river, and that those surveyed, mapped, and named by the Land Office were mere lakelets, and not identical with Lake Glazier.

Captain Glazier's claim to discovery seems, however, to be completely disposed of by the letter of H. D. Harrower in *Science* (October 8). Mr. Harrower gives a map reduced from *fac-simile*

[1] Edited by W. N. LOCKINGTON, Philadelphia.

tracings of maps of the surveys made in October, 1878. This shows " Elk Lake" in exactly the position of Lake Glazier. Into it runs a small stream, and another stream, of about equal length, flows into the western arm of Lake Itasca. The last stream heads in a tiny lakelet. Neither stream much exceeds two miles in length. Elk Lake has, of course, precedence of "Lake Glazier."

The great Lake Mistassini, regarding which exaggerated reports were afloat some time ago, has been proved to be an expansion of Rupert River, about one hundred miles in length and twelve in breadth. Depths of three hundred and seventy-four and two hundred and seventy-nine feet have been found. Above this is Little Mistassini, a widening of the river to a width of six miles.

Europe. MORESNET.—*Science*, in its Paris letter, reports a bit of political geography not generally known. It is that there is between Belgium and Germany a small and quite independent state that is smaller than Monaco, San Marino, or Anderra,—that of Moresnet. The delegates who fixed the frontier between Belgium and Germany in 1815 disagreed at this point, each wanting the mineral riches of the little spot of six square kilometres. Finally they left it independent. It had then about fifty huts, but now it is a flourishing town of more than eight hundred houses.

THE CAUCASUS is now within reach of English summer tourists, and Messrs. Dent and Donkin spent the summer of 1886 in exploring the peaks and glaciers encircling Kashtantall (17,096 feet). They ascended Tau Tetmuld (16,500 feet), and made other glacier expeditions, which will necessitate corrections in the maps of the district.

Asia and the Islands. AUSTRALIA.—The Kimberley goldfields of Western Australia lie in a fertile tract of country between King Sound and Cambridge Gulf in the tropical portion of the colony. The new town and port of Derby, on King Sound, has arisen in connection with these diggings. The entrance to the Sound, by Sunday Strait, is remarkable for the fierceness of the tide. Cambridge Gulf, at the head of which the new settlement of Wyndham is situated, is pronounced by Mr. Forrest to be one of the finest harbors of Australia, is protected from all weathers, has numerous bays, and good deep water. The "proclaimed" gold-field is two hundred and twenty miles from Wyndham by the nearest route. The gold is found in good-sized lumps, on or near the surface, near the head-waters of the Ord River, which flows into Cambridge Gulf.

FORMOSA.—The third and last of Mr. Taylor's papers on the aborigines of Formosa describes the Diaramocks, who are sup-

posed to be the true aboriginal inhabitants, without admixture with Chinese. Little is known of them, as they hold aloof from other tribes. They inhabit the mountain ranges to the northwest of the Tipuns, and are a fierce and intractable race, addicted to cannibalism. There is also said to be a tribe of red-haired savages living among the central mountains. The Pepo-huans seem to be the result of marriages between aboriginal women and whites and Chinese. The inhabitants of Formosa are intelligent, and the Chinese have a proverb to the effect that when the savages take to wearing trousers there is no room for a Chinaman.

BORNEO.—Mr. Pryer states that the natives of North Borneo are of mixed aboriginal and Chinese ancestry. On the east coast there is little of the native type left. This race, the Dusuns, is settling down under the North Borneo Company, and is thriving and increasing. In the long course of Chinese trade with the island, a slow and steady infiltration of Chinese blood took place.

Africa. THE LAST GERMAN CONGO EXPEDITION.—The last German Congo Expedition, 1884–86, made extensive land journeys. Dr. Buttner proceeded from San Salvador, the residence of the king of the Ba-Congo, to the Quango, passing through the country of the Sombo into that of the Mayakke. The Sombo are great ivory-traders. At the capital of the Muene Putu Kasonga (Kiamoo), which has about one thousand houses in its stockade, our traveller was compelled to turn northwards. Passing the Kingunshi rapids of the Kuango, he crossed the country of the Warumba. At Ngatuka a Queen Geu (Goy) is in power, and her brother rules over the Bansinik at a town which has an audience-hall that will hold one thousand people. Thence he proceeded to the Congo, which he reached above Leopoldville.

Lieutenant Kund found his way to Kiamoo, and then penetrated eastward by crossing the Quango lower down. Through the country of the hostile Bokange, he reached the Sankuru at the part inhabited by the Pambala, who were friendly. After crossing the Sankuru in boats, which were built for the purpose, the country of the Basengo or Zenge was entered. This is a primeval forest, while to the west of the river all is savanna. The villages are in clearings of the forest. All attempts to establish friendly relations with the Basengo were vain. After thirty days' journey through this forest, the westward flowing Ikatta, Lukatta or Lukenye, was found. (Lieutenant Wissman believes Dr. Wolff's Lomanie to be this river.) Farther eastward pacific relations were established with King Gakoko, ruler of the Basengo and of their smaller neighbors, the Bikalli. With the Bikalli, and with the Bavumbo beyond them, several contests occurred, resulting in the former case in the loss of two men killed and seven wounded, and in the latter in the wounding of Lieutenant Kund

himself, who was struck with three arrows, which his companion (Lieutenant Tappenbeck) cut out with a razor. The land journey was then abandoned, and the river descended in boats to the Congo. The German accounts of this expedition call attention to the fact that in many of the names of tribes, etc., those mentioned by the Portuguese missionaries may be recognized; also to the similarity between the names of tribes in this region and those of others dwelling on the Cunene or Zambezi (*i.e.*, Adima, Pende, Bayeye, Balula, Basaka, Bangola). This points either to similarity of language, or to an extensive migration of tribes.

AFRICAN NOTES.—Mr. H. H. Johnston made a journey up the Cameroons River in June last. A few miles beyond the village of Ngale Nyamsi, he obtained, from a height of five hundred feet above the river, a view of a chain of fantastically peaked mountains lying fifty to sixty miles from the river and probably ten thousand feet or more in height.

M. J. de Brazza, brother of the governor of the French Congo, reached the Sekoli (the Punga of Grenfell) by an overland journey from the Ogowé through a fertile and well-populated region, the abode of the Mbete and Ossete tribes. On the Sekoli dwell the Ikata, a commercial but warlike people. The river was descended in canoes to where it receives the Amboli and assumes larger proportions.

The French gunboat "Niger" made a voyage in the autumn of 1885 from Kulikoro to Jenne, on the Upper Niger. This part was only known from the accounts of Mungo Park and René Caillé. The once populous town of Sansandig, a considerable commercial centre in Park's time, is now a heap of ruins, having fallen a prey to the Tukaleurs. M. Davoust placed all the tribes on the left bank under French protectorate. Those on the right are ruled by Ahmadu, the Tukaleur chief.

The Rev. G. Grenfell lately read before the Royal Geographical Society of London an account of his recent explorations in the steamer "Peace." He mentions the discovery by Dr. Wolff of a river known as the Lomami which falls into the Sunkuru from the northeast, but does not believe it identical with the river of that name which flows into the Congo just below Stanley Falls, which he himself ascended as far as 1° 33′ S. lat. in January, 1885; and which at that point was a stream of thirty-five thousand feet per second, at an altitude of thirteen hundred and fifty feet above the sea.

GEOLOGY AND PALÆONTOLOGY.

Hyatt on Primitive Forms of Cephalopods.[1]—The succession of forms in any genetic series of Nautiloids is from a straight shell through a curved cyrtoceran form to a loose-coiled gyroce-

[1] Abstract of a paper read before the National Academy of Science, Boston meeting, by Alpheus Hyatt.

ran, and finally to a close-coiled nautilian shell. Among Ammonoids the same series occurs only on one occasion, at the beginning of the group, during Silurian and Devonian time, in a series which may be said to include Bactrites, a straight orthoceratitic shell, Mimoceras, a true gyroceran form, and Anarcestes, which is close-coiled. The discovery of a proto-conch upon the apex of Bactrites by Beyrich and Branco leaves no doubt that it is, as heretofore supposed by the writer, a transitional form from Orthoceras to Ammonoidea. These forms are primitive or transitional radicals and have cylindrical whorls, except in Anarcestes. In this genus a depressed semilunar whorl is for the first time introduced. This form of whorl is not at once and generally adopted in the young. On the contrary, these are usually tubular and often straight like Bactrites, or loosely coiled like the adults of Mimoceras. Others, again, after passing through a stage with tubular whorls, may become suddenly close-coiled and have at once a depressed form of whorl. Such fluctuations in embryonic characters are common even in different varieties of the same species until we reach the Trias. In this formation, or possibly earlier in the Dyas, the larvæ are all close-coiled, and the whorls at an early stage invariably have the depressed semilunar form like the adults of Anarcestes. Throughout the Trias also there occur in great abundance smooth shells, Arcestes, in which the full-grown adults are smooth and have the similar anarcestian peculiarities. Thus from the Silurian to the Trias, inclusive, the semilunar or depressed smooth whorled forms are continuous. These make up a central trunk of stock forms, which we have designated as primary radicals, confining the use of the words primitive radicals to the transitional genera Bactrites, Mimoceras, and the like.

Compressed forms differing but slightly from the depressed species occur in Anarcestes and in Arcestes, etc. In the Trias and Lias these compressed, smooth shells which we have called secondary radicals become much more important. In Psiloceras planorbe we strike upon a species of this character to which we can trace all the Arietidæ of the lower Lias and many forms of higher Jura and Cretaceous.

The great trunk of radical species has, of course, many lateral branches, which strike off from it during the course of its chronological migrations through the Palæozoic and Trias, but of these we have taken no account, because they were purely lateral offshoots which did not arise from fission or the modification of the main stock of radical generators. In the Jura, however, this main stock itself splits into branches, and the primary and secondary radical forms are replaced by more complicated radicals.

There is a side branch, which arose in the early Trias, and in which they are still, in a measure, preserved and continued, but

the main trunk line is replaced by irregular branches beginning with species which we have styled tertiary radicals. These have either the depressed or compressed form of whorl, are discoidal, and, therefore, resemble the primary and secondary radical throughout life. But, on the other hand, they are often highly ornamented with spines and ribs, and have more complicated sutures.

The tertiary radicals give rise to series of species, which may become excessively involute and otherwise modified in the higher forms, but these are never the radical generators of new forms or new series. There are, therefore, no quaternary radicals to continue the direct lines of descent from the Trias, so far as progressive forms are concerned.

But when we turn our attention to retrogressive forms, the story is different. Series of degraded or distorted forms occur in the Jura and Cretaceous, and several families afford good examples. In these series we can usually trace an origin in some close-coiled, discoidal, ornamented shell, which belongs to the tertiary radicals, or is not far removed from them in its aspect.

We have frequently pointed out the nature of these degradations. They are similar to the senile degenerations observed in the individuals of the tertiary radicals and other species of the progressive series of the Ammonoids. These geratologous transformations, whether occurring in the senile degenerations of a shell or in a series of species, tend to produce similar results, namely, the decrease in size and uncoiling of the whorl, destruction of ribs and spines, reduction of sutures to more primitive proportions. The final result, as we have often said, is a straight almost smooth shell, Baculites. We now wish to assert that Baculites is a polyphyletic group derived from many tertiary radicals, and separable into a considerable number of distinct genetic groups.—*Alpheus Hyatt.*

New Jersey Cretaceous.—The different beds of the New Jersey Cretaceous consist of layers of sedimentation, almost always conformable, which have been distinguished by the State Geological Survey as Plastic Clays, Camden Clays, Lower Marls, Middle Marls, Upper Marls, with which series in this paper the Eocene Marls have been united. Beds of sand separate these beds, and the fossils are limited to the green marls and clays. The clay-beds in their lower part have yielded five species of fossils, shells which are entirely estuarine in character, the genera recognized being Astarte, Corbicula, Gnathodon, and a new genius, Ambonicardia. This last genus resembles the Jurassic forms of Europe.

At the upper limit of the clay-beds in the clay marls are found iron-stone nodules containing casts of fossils identical with Lower Marl fossils, or with those from the Clay Marls at Cross-

wicks and Haddonfield. Their position may be in the Lower Marl-beds or in the clays proper. More study and investigation is necessary to determine this point. Lower down in the clay fossil plants occur cretaceous in character (Newberry).

The Lower Green Marls hold most of the cretaceous fossils, and this fact, together with a showing of the comparative richness in fossils of the entire series discussed, is made evident by the following tables:

Summary of Lamellibranchiata.

Formations.	Families.	Genera.	Species.
Plastic Clays	4	4	5
Camden Clays	1	2	12
Lower Marls	27	76	155
Middle Marls	8	9	11
Base of Upper Marls	12	13	16
Eocene Upper Marls	12	17	23
Total	31	89	222

Summary of Gastropods.

Formations.	Families.	Genera.	Species.
Plastic Clays	...	...	1 ?
Camden Clays	...	...	.. ..
Lower Marls	25	60	125
Middle Marls	5	6	7
Base of Upper Marls	7	8	8
Eocene Upper Marls	21	29	52
Total	31	80	190

Summary of Cephalopods.

	Species.
Lower Marls	11
Middle Marls	1
Eocene Marls	2

General Summary of Species.

	Cretaceous.	Eocene.
Brachiopods	5	2
Lamellibranchiata	199	23
Gastropoda	138	52
Cephalopoda	12	2
Total	354	79

The fossils are usually restricted to single beds, at most only four molluscan forms, passing from one bed to another. The zoological break is conspicuous, but is accompanied by no geological unconformity, a slight exception to this being seen only at the junction of the Eocene Marl-beds and the layers immediately below it. The brachiopods, so common a feature in the Cretaceous of Europe, are proverbially rare in American strata of this age, only five species being recognized, all Terebratulidæ.

Of the brachiopods, *Terebratula harlani* and *T. lachryma* occur in South Carolina, and *T. floridana* in Alabama.

Of Lamellibranchiates of the Lower Marl-beds of New Jersey,—

41	species are known	from	Alabama.
21	"	"	Tennessee.
21	"	"	Mississippi.
6	"	"	Texas.
20	"	"	North Carolina.
4	"	"	Dakota.
3	"	"	Europe.

Of the Middle Marl-bed species,—

Alabama	has	3	species.
Tennessee	"	1	"
Texas	"	1	"
Dakota	"	1	"

Of the Eocene species, *Crassatella alta* is the only species known from any other State.

Of the Gastropods, which have been less studied in the Southern States,—

North Carolina	has	1	species.
Tennessee	"	2	"
Alabama	"	12	"
Mississippi	"	7	"
Texas	"	1	"

Of the Cephalopods, most have been recognized in Alabama and Texas. Of the Eocene Gastropods, ten occur in Alabama.

Of the two hundred and twenty-two species of Lamellibranchiates, seventy-four of them are new species; and of one hundred and ninety species of Gastropods, one hundred and seven are new. Comparison permits the conclusion arrived at before by others on less extensive determinations, that the New Jersey Cretaceous Marls are the equivalent of No. 4 or of Nos. 4 and 5 of the Upper Missouri Section.

The work done on the Cretaceous is yet fragmentary, as many specimens are too imperfect for use, and the middle and base of the upper marls have not been systematically examined.—*R. P. Whitfield.*

Geological News. GENERAL.—A catalogue of the Blastoidea in the Geological Department of the British Museum of Natural History is the joint work of Mr. R. Etheridge and Mr. P. H. Carpenter. The Blastoids are given a position as a group equivalent in rank to the brachiate Crinoids. The term Pelmatozoa, or palmed animals, includes the crinoids and cystids, and the class Blastoidea have the following peculiar characters among others: A subambulacral lancet-plate which is pierced by a canal that lodged the water-vessel, the absence of under-basal plates, the constant presence of five interradials, the constant but peculiar trimerous symmetry of the base, a character previously observed

only in one cystid and possibly in one crinoid, and the very symmetrical grouping of the hydrospires, which are limited to the radial and interradial plates, and have their slits parallel to the ambulacra. The Blastoids are the most regular of Echinoderms. All have thirteen plates except Pleqcrinus, in which one is divided.

Silurian.—E. O. Ulrich has published descriptions of new Silurian and Devonian fossils, chiefly Polyzoa, and describes as new genera Busiopora and Lichenotrypa.

Palæozoic.—Rohon and Zittel have recently studied the histological structure of the conodonts. As a result, they declare that they differ entirely from true teeth or the so-called teeth of lampreys and of Mollusca, and do not resemble any part of the hard parts of Crustacea, but they agree closely with the teeth of Annelid and Gephyrean worms.

Tertiary.—The second number of the Annals of the New Natural History Museum at Vienna contains an important paper upon the Miocene pteropods of Austro-Hungary, by Ernst Kittl. Illustrations of most of the species are given, and ten new species described.

Pliocene.—The flora of the Cromer Forest-bed (England) has been investigated by Mr. Clement Reid, who found in various samples of dark peaty sandy clays, the seeds or fruits of forty species of dicotyledons, eighteen of monocotyledons, five of gymnosperms, and three cryptograms, besides some mosses and Characeæ. With a few exceptions, the same plants still exist in the locality.

Quaternary.—Professor Lindström believes, from the configuration and structure of the rock-terraces in Gottland, Sweden, that the island received its present form by denudation, previous to the Glacial period, and that various changes of level have taken place since that time. Raised beaches are traced in Gottland at various elevations up to two hundred and fifty-nine feet above sea-level, the highest point on the island. Erratic bowlders are traced from the Aland Isles, possibly from the southwest of Finland, and from the bed of the Baltic.

Dr. Nathorst gives his adhesion to the belief that pebbles with distinctly faceted surfaces are due to the action of wind-driven sand. Mr. Travers, in 1869, first called attention to such pebbles, and thus explained their origin. Similar pebbles have been discovered in the Eophyton sandstone at Lugnas, Sweden.

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—Mr. G. A. J. Cole[2] has recently attempted to explain the occurrence in rocks of "hollow spherulites" like the lithophysen of Von Richthofen. The principal theories proposed to account for these bodies are discussed, and that one is accepted which regards them as the result of the alteration of spherulites, in preference to the one in which a vesicular origin is assigned them. The present writer thinks that a study of the phenomena attending the alteration of spherulites will explain satisfactorily the occurrence of the hollow spherulites. In many of these there is often found a little patch of felsitic material with a radial structure, and from this Mr. Cole argues that the whole body was once of the same nature, and that the greater part of the original filling has been removed by decomposing agents, probably through the channels afforded by perlitic cracks. He then examines[3] many of the spherulitic rocks of Great Britain and some from localities in Europe and America, and finds that his views are on the whole confirmed.——Professor Milne, in a recent number of the Transactions of the Seismological Society of Japan,[4] states that the lavas of the Japanese volcanoes (one hundred in all, of which forty-eight are still active) are chiefly andesites, the hornblende varieties of which frequently contain quartz. Those containing olivine approximate to basalts, though true basalt is rare. A critical study of these rocks is now being made by members of the Japanese Survey.——A microscopical examination[5] of the volcanic ash ejected during the recent eruption in New Zealand shows it to contain fragments of limpid plagioclase crystals, dark green pleochroic hornblende, sometimes fibrous, and extinguishing at 15°, biotite and a "golden-colored mica" in well-formed crystals of hexagonal outline, pyrite, magnetite, broken pieces of sulphur, and glass containing crystallites arranged in flow-lines.——By treatment of the granite-porphyry from Beucha with hydrofluoric acid, and then the residue thus obtained successively with various other acids, Kroustshoff[6] has succeeded in isolating from it small colorless isotropic crystals with glassy inclusions. These crystals possess a specific gravity greater than 3, a refractive index equal to that of garnet or spinel, and show, before the spectroscope, the lines of iron, calcium, magnesium, and aluminium. The author calls attention to the similarity between these crystals and those which he obtained in a like manner from the phonolite[7] of Olbrück, and

[1] Edited by Dr. W. S. Bayley, Madison, Wisconsin.

[2] Quart. Jour. Geol. Soc., xli., No. 162, May, 1885, p. 162.

[3] Ib., xlii., No. 166, May, 1886, p. 183.

[4] Vol. x. part 2, Abst. Nature, Nov. 4, 1886, p. 19.

[5] J. Joly, Nature, Oct. 21, 1886, p. 595.

[6] Note sur un nouveau minéral accessoire de la roche de Beucha (près de Leipzig). Bull. de la Soc. Franç. de Minéralogie, ix., No. 4, 1886; also Neues Jahrb. für Min., etc., 1886, ii. p. 180.

[7] Ib., ix., No. 3.

which he believes are members of the spinel group. A mineral very like those above mentioned also occurs in the tonalite from Adamello. The same author, in another paper, describes a peridotite[1] from Goose Bay, in the Straits of Magellan. It consists essentially of olivine and enstatite, with picotite and apatite as accessory minerals, and serpentine, chrysolite, bastite, and magnetite as secondary constituents. The olivine contains gas, liquid and glass inclusions. The fibres of the bastite seem to have been curved by some mechanical agency (pressure). An analysis of a comparatively fresh specimen yielded,—

SiO_2	Al_2O_3	Fe_2O_3	Cr_2O_3	Fe(Mn)O	MgO	CaO	H_2O
43.39	2.26	0.35	0.28	10.47	39.89	2.33	1.54

——Basalts, pyroxene-andesites, hornblende-pyroxene-andesites, hornblende-mica-andesites, and dacites, very like similar rocks occurring in the western portion of our own country, are described by Messrs. Hague and Iddings[2] from the Republic of Salvador, Central America.——Certain "Pliocene sandstones" from Montana and Idaho, according to Mr. G. P. Merrill,[3] consist of pumiceous dust cemented by calcite or clayey material. An analysis of one of these from Little Sage Creek, Montana, yielded Mr. Whitfield,—

SiO_2	$Fe_2O_3 + Al_2O_3$	CaO	MgO	Na_2O	K_2O	H_2O	loss by ignition
65.56	18.24	2.58	0.72	2.08	3.94	1.12	6.50

Mineralogical News.—The lithia micas of Maine and the iron-lithia micas of Cape Ann, Mass., have been subjected to a very thorough chemical examination by Mr. F. W. Clarke and the gentlemen associated with him in the chemical department of the U. S. Geological Survey. The various types of these minerals, from different localities in the States named, have been analyzed, and the results of these analyses are given in a paper in the *American Journal of Science.*[4] By supposing fluorine to replace the hydroxyl (HO) group in ortho-silicic acid, a series of fluo-silicic acids may be obtained as a nucleus upon which to build the formulæ representing the composition of the various lithia micas. For example, if we represent muscovite by $\mathrm{Al}\begin{array}{l}\diagup SiO_4 \equiv R_3\\ — SiO_4 = Al\\ \diagdown SiO_4 = Al\end{array}$, then lepidolite might be represented by

$$\mathrm{Al}\begin{array}{l}\diagup SiFO_3 = R_2\\ — SiO_3 \;\diagdown\\ \diagdown SiFO_3 \;/\!\!/ \end{array}\!\!\mathrm{Al}, \text{ and cryophyllite by } \begin{array}{l}\mathrm{Al}\begin{array}{l}\diagup SiFO_3 = R_2\\ — SiO_3 — R\\ \diagdown SiO_3.\end{array}\\ \mathrm{Al}\begin{array}{l}\diagup\\ — SiO_3 — R\\ \diagdown SiFO_3 = R_2.\end{array}\end{array}$$

[1] Note sur un nouveau minéral accessoire de la roche de Beucha (près de Leipzig). Bull. de la Soc. Franç. de Minéralogie, ix., No. 1; also Neues. Jahrb. für Min., etc., 1886, ii. p. 180.

[2] Amer. Jour. Sci., xxxii., July, 1886, p. 26.

[3] Ib., Sept. 1886, p. 199.

[4] November, 1886, p. 353.

——Messrs. Penfield and Harper[1] have carefully analyzed pure *ralstonite* from Greenland, and have found it to contain,—

Mg	Na	K	Ca	Al	F	H_2O	total
4.46	4.27	0.12	0.03	24.25	39.96	18.73	91.70

Upon calculation it was found that the amount of fluorine obtained in the analysis was not sufficient to unite with all the metals; hence these authors assume that the metals which are in excess of the fluorine combine with hydroxyl. If this be true, the composition of ralstonite as calculated from the analysis is as follows:

Mg	Na	K	Ca	Al	F	OH	OH_2
4.39	4.27	0.12	0.03	24.25	39.91	16.27	10.12 = 99.36,

and the mineral may be regarded as an isomorphous mixture of $(MgNa_2)Al_3F_{11}.2H_2O$ and $(MgNa_2)Al_3\ (OH)_{11}$.——The mineral which best illustrates the power of fluorine to replace hydroxyl in a chemical compound is *herderite*, which has recently been shown[2] by these same investigators to consist of an isomorphous mixture of $CaBeFPo_4$ and $CaBe(OH)Po_4$.——*Lucasite*, a new variety of vermiculite, from Corundum Hill, Macon County, N. C., is described by Mr. T. F. Chatard[3] as a foliated mineral of a yellow-brown color, with eminent basal cleavage and a submetallic, greasy lustre. It dissolves in hydrochloric acid and exfoliates when heated, swelling at the same time to twice its original volume. It is biaxial and negative, with a small optical angle.——The well-known garnet pseudomorphs from the Lake Superior region have been examined by Messrs. Penfield and Sperry.[4] According to these gentlemen the alteration of the garnet consists in a slight oxidation of its iron, a decrease of its silica, an almost total disappearance of its manganese and calcium, and an increase in its magnesium, alkalies, and water. The resulting mineral is a ferrous chlorite[5] with a composition approaching that of prochlorite. An examination of a decomposed garnet from Salida, Colorado, yielded the same result.——Some very fine pseudomorphs of limonite after pyrite are figured by T. G. Meem[6] in the October number of the *American Journal of Science*, in which the striations due to the oscillation of the octahedron and icositetrahedron are well preserved.

Meteorites.—During the past summer quite a number of short articles descriptive of meteorites have appeared in the *American Journal of Science.* In the June number Mr. W. E. Hidden[7] describes two masses, neither of which was seen to fall. One is a meteoric iron, found in Independence County, Ark. It weighs ninety-four pounds. A curious feature in connection with it

[1] Amer. Jour. Sci., Nov. 1886, p. 380.
[2] Penfield and Harper, Amer. Jour. Sci., xxxii., Aug. 1886, p. 107.
[3] Amer. Jour. Sci., xxxii., Nov. 1886, p. 375. [4] Ib., Oct. 1886, p. 307.
[5] *Cf.* American Naturalist, Feb. 1886, p. 161.
[6] Amer. Jour. Sci., xxxii., p. 274. [7] Ib., xxxi., No. 186, p 460.

is the existence through it of a hole measuring five-eighths of an inch in diameter at its narrowest part. Its composition is Fe = 91.22; P = 0.16; Co and Ni = 8.62; thus belonging to the class holosiderite of Brezina. The second mass is from Laurens County, S. C. Its composition, as determined by Mr. J. B. Mackintosh, is as follows: Fe = 85.33; Ni = 13.34; Co = 0.87; P = 0.16. The Widmanstättian lines indicate a regular crystallization. The presence of occluded hydrogen and little masses of ferrous chloride (lawrenceite) in its mass render this meteorite exceedingly interesting. In the October number the same author[1] describes a meteor found at Fort Duncan, Maverick County, Texas. It weighs ninety-seven and a quarter pounds, and contains 94.90 per cent. Fe; P = 0.23; Ni and Co = 4.87. Sp. gr. = 7.522. Its peculiarity is the development in it of two series of very fine lines crossing each other at an angle of 70°.——Since the publication of the article[2] on the three masses of meteoric iron from Glorieta Mountain, New Mexico, four other pieces of the same meteorite have been found. An analysis by Mr. Eakins, of the United States Geological Survey, of what is supposed by Mr. Kunz[3] to be the seventh piece of this meteorite, yielded,—

Fe	Ni	Co	Cu	Zn	Cr & Mn	C	P	S	Si
88.76	9.86	0.51	0.03	0.03	traces	0.41	0.18	0.01	0.04

——The crystalline structure of meteoric irons has been well worked out by O. W. Huntington,[4] who examined the collection of these bodies belonging to Harvard College. By a very careful investigation of the appearance of the Widmanstättian figures on cleavage faces of the different specimens, and by comparison of similar appearances in the case of many minerals, which, during their crystallization, extruded various impurities (as, for instance, many micas containing magnetite), Mr. Huntington is led to conclude that (I.) many meteoric irons show cleavages parallel to the principal planes of symmetry in the isometric system; (II.) that the Widmanstättian figures and Neumann lines are sections of planes of crystalline growth parallel to the three planes mentioned; and (III.) that the features of the Widmanstättian figures are due to the elimination of incompatible material during the process of crystallization. The results of the investigation strengthen the belief that meteoric irons were thrown off from the sun or one of the fixed stars, and that they have cooled very slowly, while revolving in a zone of intense heat.——A meteoric stone found in Utah, between Salt Lake City and Echo, according to Messrs. E. S. Dana and S. L. Penfield,[5] appears under the microscope to consist of spherules of olivine, some of which have a distinct coarsely fibrous structure in consequence of the inclu-

[1] Amer. Jour. Sci., Oct. 1886, p. 304.
[2] G. F. Kunz, ib., III. xxx. p. 235; *cf.* American Naturalist, Dec. 1885, p. 1214.
[3] Ib., xxxii., Oct. 1886, p. 311. [4] Ib., III., xxxii., Oct. 1886, p. 284.
[5] Amer. Jour. Sci., xxxii., Sept. 1886, p. 226.

sion of dark-colored glass, bronzite in broken fragments and also in spherules with a fine fibrous structure, broken plagioclase, rich in black inclusions lying parallel to the twining planes, and, finally, patches of an isotropic mineral, probably maskelynite. It contains the following constituents: nickeliferous iron, 17.16 per cent.; mineral portion, 82.84 per cent. The iron yielded upon analysis, Fe = 91.32 per cent.; Ni = 8.04; Co = 0.60; Cu = 0.04. The mineral portion was divided into two parts, one soluble in hydrochloric acid yielded, FeS = 6.08; NiS = 0.62; and 48.85 per cent. silicates; the other, insoluble in this acid, gave, chromite 0.75, and 43.22 per cent. silicates. A second meteorite, from Cape Girardeau, Missouri, proved, upon examination, to belong to the same general class as the one last mentioned.——A catalogue of the meteoric stones in the collection of Yale College, one hundred and forty-seven in number, is published as an appendix in the same number of this journal. ——Perhaps the most important paper on meteorites which has appeared during the year is that of Reusch.[1] In this are described four Scandinavian meteorites, each of which presents interesting features. The most noteworthy of these is the occurrence of olivine in forms imitative of organic structures, and also, together with bronzite, forming spherulitic bodies in a ground-mass composed of crystals of bronzite, augite, and iron in a glassy base. The most instructive fact in this connection is the discovery of a brecciated structure in two of the meteors described. The rounder grains which occur in the crystalline ground-mass surrounding them are of the same nature as this ground-mass, and are in turn composed of other smaller grains of similar mineralogical composition. A gradual transition from the large fragmental particles to the "chondra" was traced, and from this fact, in connection with the others above mentioned, the author draws certain general conclusions in regard to the origin of meteoric bodies, which, although exceedingly interesting, it would be impossible to incorporate in these notes in any logical sequence.

Crystallographic News.—Quite a number of new measurements of crystals have recently been made by Mr. E. S. Dana.

GOLD[2] from the White Bull Mine in Oregon possesses the form $3O3$. The crystals are distorted so as to assume a rhombohedral symmetry. Crystals of gold from California showed a persistence of the hexakisoctahedron $18O\frac{9}{5}$.

THE BROOKITES[3] from Magnet Cove are divided for the sake of convenience into those of prismatic habit and those in which the pyramid is the predominating form. Twenty-five figures of typical crystals are pictured.

[1] Neues Jahrb. f. Min., etc., Beil., Bd. iv., 1886, p. 473.
[2] Amer. Jour. Sci., xxxii., Aug. 1886, p. 132.
[3] Ib., xxxii., Oct. 1886, p. 314.

Columbite.[1]—A number of new crystals of this mineral from Standish, Maine, have been measured, and from the data thus obtained a recalculation of the axial ratio has been made. According to the new measurements, $a : b : c = .40234 : 1 : .35798$ (Schrauf's position) and $.8285 : 1 : .88976$ (Dana's position). The species is without doubt orthorhombic. Differences in composition appear to have little effect on the value of interfacial angles.

Diaspore.[1]—The two new planes $\check{P}\frac{4}{3}$ and $\check{P}2$ were discovered on a fine crystal of diaspore from Chester, Mass.

Sulphur.[1]—$\frac{1}{4}P$ and $\frac{3}{5}P\overline{3}$ are described as new forms on sulphur from Rabbit Hollow, Nev.

——Among some remarkably fine crystals of *hiddenite*, *xenotime*, *monazite*, and *quartz* from North Carolina, Mr. Hidden[2] mentions having found on the latter a well-developed basal plane which yielded to Professor Des Cloizeaux, $OP \wedge R = 128°$, the calculated angle being 128° 13′. On black *tourmaline* from Sharpe's township, Alexander County, the new form $\frac{3}{5}R$ was detected. On *xenotime* from the same county $3P$ was found, and on *herderite* from Stoneham, Maine, the new plane $P\overline{\infty}$. A twinned crystal of *molybdenite* from Renfrew, Canada, suggests that this mineral may crystallize in the hexagonal system with its planes hemimorphically developed.

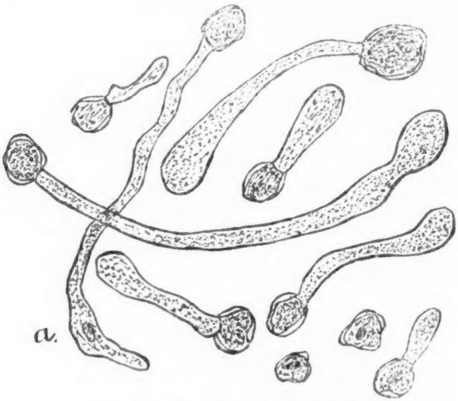
BOTANY.[3]

Pollen-Tubes of Lobelia.—In the American Naturalist, vol. xx. page 644, the pollen-tubes of *Lobelia syphilitica* were shown in the tissue of the style with enlarged or club-shaped tips. The hope was then expressed of germinating the pollen this summer, and determining the shape of the tubes when growing freely in the sugar solution. The *L. syphilitica* not being at hand, flowers of *L. cardinalis* were examined, and in every open flower the pollen within the tube made by the union of the anthers was found germinating in great abundance. The accompanying engraving shows a number of these pollen-tubes illustrating the various characteristic forms. The prevailing shape is like that of *L. syphilitica* as found penetrating the conductive tissue of the style. The nucleus of the pollen-grain is well brought out by acid azo-rubin, and in nearly all cases was found centrally located and varying from oblong to kidney-shaped. In only a few instances had the nucleus passed out of the pollen-grain. At *a* is shown a nucleus in an enlarged place in the tube near the tip. The three lower and right-hand grains are drawn as seen after the nucleus has taken the dye.

[1] Amer. Jour. Sci., xxxii., Nov. 1886, p. 386.
[2] Ib., xxxii., Sept. 1886, p. 204.
[3] Edited by Prof. Charles E. Bessey, Lincoln, Nebraska.

It remains to be seen what the shapes of the pollen-tubes are in the *L. syphilitica* when growing free from the tissue of the style.

Several flowers of *L. cardinalis* were examined before the corolla had opened, and in none were the pollen-grains germinating. A careful examination of the styles, ovaries, and ovules of flowers containing germinating pollen in the anther-tube but not yet having the stigmatic surface protruding beyond the anthers, and therefore unexposed, did not show any signs of fertilization. The pollen-tubes were often extending over the surface of the style, but they were not found penetrating its tissue.



Pollen-tubes of *Lobelia cardinalis*.

Less than half an inch of rain has fallen in this locality during the past eight weeks, and, therefore, these plants are passing through an unusual drought. There is a lack of vitality in these plants as a whole, and the flowers are apparently unable to fully perform their functions. The rosette of hairs on the style just below the stigma fails to carry up the pollen, partly because the hairs are feebly developed, and also because the stigma is not protruded to its usual length. The lobelia flower is admirably adapted for cross-fertilization, and we should not expect to find here a case of the closest kind impregnation, and yet there is sufficient suspicion to warrant further careful watching.—*B. D. Halsted, Botanical Lab. Agricul. Coll., Ames, Iowa.*

The Tree-Trunk and its Branches.—In order to determine quantitatively the general relations between the tree-trunk and its branches, the writer has in the past few years made three hundred observations on the white-oak, cottonwood, and other deciduous trees of the Northern States, and one hundred observations on the white pine in Tennessee. In each of these four

hundred cases the circumference of the trunk[1] was carefully measured a few inches below the point of branching, and also the circumferences of the branches a few inches above the same point. The measurements were made a little above and below the crotch in order to avoid the extra swelling usually occurring at that point. In each instance the area of the trunk circumference was compared with the sum of the areas of the limb circumferences. In this way it was found that the limbs just above point of branching on the average contain eleven per cent. more wood than does the trunk just below the same point. This general fact may be somewhat interesting, but it is not very significant. In the economy of the tree, constantly strained and bent by the wind, strength is far more important than mere bulk. In order to determine the relative strength of the tree-stem and its branches, the cubes of the trunk circumferences were compared with the respective sums of the cubes of the corresponding limb circumferences.[2] This comparison showed that in ninety-five per cent. of the four hundred observed cases the trunk just below the crotch was stronger than all the limbs just above the same point. And on the average the trunk was found to be thirteen per cent. stronger than the sum of all its branches coming from one point. Now practically just above the crotch the branches have to support the same burden as does the trunk just below that point, then why is the trunk made stronger than its limbs? Well, even if a branch or several branches are broken by the wind, the tree can still grow and reproduce its kind, but if the trunk be broken the tree receives a much greater injury. Thus in general although the limbs of a tree are more bulky than the main stem, yet at practically the same elevations the trunk, by the constant action of the wind, is kept decidedly stronger than all its branches.—*B. F. Hoyt, Manchester, Iowa.*

The Article "Schizomycetes" in the Encyclopædia Britannica.—The twenty-first volume of the ninth edition of the "Encyclopædia Britannica" contains a valuable summary of our knowledge of the Schizomycetes, from the pen of H. Marshall Ward. In this discussion the writer considers the Bacteria only, evidently agreeing with many modern writers in considering the Yeast Fungi (Saccharomycetes) as having stronger affinities elsewhere than with the Bacteria. In a short historical introduction, it is stated that "Leeuwenhoek figured Bacteria as far back as the seventeenth century, and O. F. Müller knew several important forms in 1773, while Ehrenberg in 1830 had advanced to the commencement of a scientific separation

[1] Any relatively large part of the tree having branches was considered as a trunk, and several observations were frequently made among the larger limbs of the same tree.

[2] According to an established principle of mechanics, the strength of solid bodies of same form and substance is in proportion to the cubes of their like dimensions.

and grouping of them, and in 1838 had proposed at least sixteen species, distributing them into four genera." Cohn's work (1853–1872) gave us the first really accurate knowledge of these organisms. He assumed the practical constancy of the forms met with, and accordingly described them as species and genera, taking *form* for his principal character. Later students of the Bacteria have shown that Cohn's species and genera often occur as phases in the life-history of a particular bacterium. What the specific limits are in many cases has not yet been determined. Zopf showed several years ago that "minute spherical cocci, short rodlets ('Bacteria'), longer rodlets ('Bacilli'), and filamentous forms ('Leptothrix'), as well as curved and spiral threads ('Vibrio,' 'Spirilum,' etc.), occur as vegetative stages in one and the same schizomycete."

With these facts before us, it is at once evident that Cohn's classification breaks down entirely. No stable arrangement can be hoped for in the present state of our knowledge. Accordingly, a good deal of attention is now directed to the study of the various vegetative and reproductive states, including also the details as to their parasitic and saprophytic habits, and their deportment under cultivation. The chief vegetative forms are the following, viz.:

Cocci, spherical or spheroidal cells.

Rods or rodlets, slightly, or more considerably elongated cells.

Filaments, elongated cylindrical cells, united end to end in long threads.

Curved or spiral forms, rods or filaments more or less curved.

To these should be added the so-called zooglœa, or resting stage, in which the cell-walls swell up and form a gelatinous matrix. Spores are known to occur in most Bacteria, and these have been observed to germinate in several forms. Two principal types of spore formation are distinguished, viz.: 1, by the breaking up (fission) of the filament into its ultimate segments or joints (arthrospores); 2, by the formation of spores within the cell or filament (endospores).

The provisional outline of a classification of Bacteria given is a modification of De Bary's, as follows, viz.:

Group A. Asporeæ.

No spores distinct from the vegetative cells.

I. Coccaceæ, including the genera, 1, *Micrococcus*; 2, *Sarcina*; 3, *Ascococcus*.

Group B. Arthrosporeæ.

Spores produced by segmentation.

II. Arthrobacteriaceæ, including, 4, *Bacterium*; 5, *Leuconostoc*; 6, *Spirochæte* (?).

III. Leptotricheæ, including, 7, *Crenothrix;* 8, *Beggiattoa;* 9, *Phragmidiothrix* (?); 10, *Leptothrix.*

IV. Cladotricheæ, including, 11, *Cladothrix.*

Group C. Endosporeæ.

Spores produced within the cells or filaments, including, 12, *Bacillus;* 13, *Vibrio* (?); 14, *Spirillum.*

In their relations to diseases the writer of the article unequivocally accepts the view that they are the cause, not the accompaniment. As to the mode of action he says, "If it [a bacterium] robs the blood or tissues of oxygen or of any other valuable constituent, or if its activity results in the excretion of poisonous substances, or in their formation as products of degradation of the matrix, or if it simply acts more or less as a mechanical obstruction or irritant,—in any of these cases harm may result to the delicately adjusted organism of the host." But "the living tissues of a healthy animal exert actions which are antagonistic to those of the parasitic invader; and it is now generally admitted that the mere admission of a Schizomycete into an animal does not necessarily cause disease. Were it otherwise, it would be difficult to see how the higher organisms would escape at all."

Botanical Journals.—The writer of this note has had during the past seventeen years, the period covered by his botanical teaching, many inquiries from beginners in botany as to what botanical journals it would be best for them to read. The replies have varied according to what appeared to be the individual needs of the inquirers. Recent inquiries from young botanists in widely-separated localities suggest the need of a short paper by way of guidance to those who would, if they could, read one or more botanical journals.

Nowadays, in any line of work, one who wishes to be progressive must read the proper journals. The young teacher who expects to keep up with the discoveries in his specialty without reading some of the journals devoted to that specialty will find himself in a few years hopelessly behind his reading fellow-workers. He must read, and he must read the best. He cannot afford to read anything less than the best. What shall he read? In answer to this it may be said that it is the duty of every teacher to so far hold his "specialty" in check that he shall be first and foremost a *botanist,* one who has knowledge of, and an interest in, all portions of the great science of plants. Let him be primarily a botanist, and then, if he has the inclination, secondarily a phanerogamist, a caricologist, a pteridologist, a bryologist, a lichenologist, a mycologist, an algologist, a phytotomist, or a vegetable physiologist, etc. The teacher may, and probably should be, a specialist, but he must be a botanist in the broadest sense first. His duty to his pupils is to instruct them in botany,—

the science of plants,—not in some narrow department of it. He must lay the foundation for *any* specialty, not for a particular one. Some of his pupils will become phanerogamists, some caricologists, some graminologists, some pteridologists, and so on, and he must be ready to guide them intelligently in their work. He must keep himself well informed in every department of the science.

There are three journals in the United States devoted entirely to botany. They occupy somewhat different fields, and accordingly have different values for different people. *The Botanical Gazette*, now eleven years old, is "devoted to all subjects which relate to botanical science." From the beginning the structural and physiological side of botany has been emphasized as much as possible, but the systematic botany of all the grand divisions of the vegetable kingdom has received due attention. From this journal the young botanist will obtain a very good idea of modern botany in all its departments. *The Bulletin of the Torrey Botanical Club* is the oldest of our botanical journals. For many years it was, as its name indicates, devoted mainly to local botany, being the organ of a botanical club in the city of New York. Systematic botany has always predominated in this journal, and its pages contain the descriptions of many new species. Since 1880 it has been given a wider range, and now includes papers on all botanical subjects, and is well adapted to help the young botanist. These are the best botanical journals for the teacher, with which the present writer is familiar in any country. There is nothing abroad which comes near to them in general helpfulness. *The Journal of Botany* (London) is practically confined to the systematic botany of the flowering plants and the pteridophytes, and for those teachers who are solely interested in this phase of the science this journal will be found very valuable. The *Botanische Zeitung* is almost entirely given over to the anatomical and physiological side of botany. *Flora* (Regensburg), with much the same tendency as the last, includes many papers on systematic botany.

Of special journals,—*i.e.*, those devoted to particular branches of the science,—we have one in the United States, viz., *The Journal of Mycology*, now two years old. As its name indicates, it is devoted exclusively to the botany of the fungi. Thus far special attention has been given to the description of new species and synopses of various families, with descriptions of the species. It is indispensable to the student of the fungi. The English journal, *Grevillea*, takes a wider range, aiming to be a "record of cryptogamic botany and its literature." Its articles are for the most part systematic, relatively few of them being structural or physiological. *Hedwigia* (Dresden) is much like *Grevillea* in plan and execution. A most valuable special periodical, of an entirely different character, is the *Journal of the Royal Microscop-*

ical Society, which contains (in addition to much other matter) summaries of current botanical researches, including the anatomy and physiology of phanerogams and cryptogams, and the systematic botany of the latter.—*Charles E. Bessey.*

ENTOMOLOGY.

Preliminary Descriptions of Ten New North American Myriapods.—The following new species are in the Museum of the Indiana University; they have been collected by different persons from various parts of the United States; those from Bloomington, Ind., being obtained by myself. The types of these will be deposited in the Smithsonian Institution.

1. *Lithobius howei* n. sp.—Brown; antennæ 20 jointed; ocelli 25–7; prosternal teeth 6; coxal pores 5, 5, 6, 5; spines of the first pair of feet 2, 3, 2; penultimate lost; last 1, 3, 3, 1; length 15 mm. *Hab.* Fort Snelling, Minn. (W. D. Howe.)

2. *Lithobius pullus* n. sp.—Brown; antennæ 20 jointed; ocelli 12–5; prosternal teeth 4; coxal pores 3, 4, 3, 3–2, 2, 2, 2; spines of the first pair of feet 1, 3, 2–1, 2, 1; penultimate 1, 3, 3, 2–1, 3, 3, 1; last 1, 3, 3, 1–1, 3, 3, 0; claw of the female genitalia tripartite; length 9–11 mm. *Hab.* Bloomington, Ind.

3. *Lithobius minnesotæ* n. sp.—Brown; antennæ 20 jointed; ocelli 13–6; prosternal teeth 4; coxal pores 4, 5, 5, 4; spines of the first pair of feet 1, 3, 2; penultimate 1, 3, 3, 1; last 1, 3, 2, 1; claw of the female genitalia tripartite; length 16 mm. *Hab.* Fort Snelling, Minn. (W. D. Howe.)

4. *Lithobius trilobus* n. sp.—Brown; antennæ 20 jointed; ocelli 22–8; prosternal teeth 4; coxal pores 3, 4, 4, 3–3, 4, 4, 4; spines of the first pair of feet 1, 3, 1; penultimate 1, 3, 2, 1–1, 3, 1, 0; last 1, 3, 1, 0; claw of the female genitalia tripartite; length 10–11 mm. *Hab.* Bloomington, Ind.

5. *Lithobius proridens* n. sp.—Yellow-brown; antennæ 24–29 jointed; ocelli 15–6; prosternal teeth 10–12; coxal pores 4, 6, 5, 5–3, 4, 4, 3; spines of the first pair of feet 3, 3, 2–2, 3, 1; penultimate 1, 3, 3, 2–1, 3, 3, 1; last 1, 3, 3, 2–1, 3, 3, 1; claw of the female genitalia whole; length 10–12 mm. *Hab.* Bloomington, Ind.

6. *Lithobius cardinalis* n. sp.—Brown; antennæ 20–31 jointed; ocelli 10–6; prosternal teeth 4; coxal pores 2, 4, 3, 2–2, 2, 3, 2; spines of the first pair of feet 2, 3, 2; penultimate 1, 3, 3, 1; last 1, 3, 3, 2–1, 3, 3, 1; claw of the female genitalia tripartite; length 6–9 mm. *Hab.* Bloomington, Ind.

7. *Scolioplanes ruber* n. sp.—Bright red; attenuated anteriorly and posteriorly; sternum cordiform; frontal plate present; prebasal plate concealed; ventral plates with a large, median foveola; pairs of feet in the male 67–69, female 71–73; length 53 mm. *Hab.* Bloomington, Ind.

8. *Iulus ellipticus* n. sp.—Resembles *I. impressus.* Vertex with

a median sulcus; eyes nearly elliptical; ocelli about 55, in 8 series; segments 46; first segment semicircular, not striate; anal spine stout, projecting beyond the valves; length 25 mm. *Hab.* Fort Snelling, Minn. (W. D. Howe.)

9. *Iulus burkei* n. sp.—Rather stout; brown, with a series of dark dots on each side; vertex with a median sulcus; eyes triangular; ocelli 17, indistinct, in 4 series; segments 45–47; first segment produced forward to the eyes, not striate; last segment rounded; anal valves marginate; length 14 mm. *Hab.* Ukiah, Cal. (J. K. Burke.)

10. *Fontaria virginiensis brunnea* n. var.—This new variety can be easily distinguished from *virginiensis* by its color and form of last segment. Chestnut-brown, lateral plates and under parts yellow, a black, median dorsal line; last segment very blunt, sparsely pilose.—*Charles H. Bollman, Indiana University, Nov.* 27, 1886.

Mimicry in a Caterpillar.—S. E. Peal, writing from Assam to *Nature*, notices a singular case of mimicry on the part of a caterpillar, which, when suddenly surprised, erects its head in an attitude that caused the writer to mistake it for a shrew, probably the very animal that preys upon it. The resemblance is caused by two lateral prolongations and a pointed tip to the head; these when lifted in the peculiar attitude assumed simulate ears and a long muzzle, while the mouth parts in profile look like the mouth of a vertebrate.

The same writer states that the tiger causes the Sambur deer to run to it by uttering a whistle which only an expert can tell from that of the deer. The eye and nose lumps of a crocodile are so like lumps of foam that Mr. Peal confesses he has been deceived until he saw the supposed foam sink. He believes this simulation useful to the crocodile in obtaining its food.

A female chimpanzee in the Bidel menagerie, now at Paris, has been seen to weep as the climax of her grief when deprived of a child playmate.

ZOOLOGY.

A. S. Packard on the Cave Fauna of North America, with Remarks on the Anatomy and Origin of Blind Forms.[1]—The author briefly describes some of the larger caves, with notes on their hydrography, temperature, origin, and geological age, the food-supply of the inhabitants, the means of entering or colonizing the cavern, and lists of each cave fauna. These notes are followed by a systematic description of the animals and their geographical distribution. A comparative list of American and European cave animals shows that in America there are about sixty-two species to about one hundred and seventy-five in

[1] Abstract of a paper read before the National Academy of Sciences, November, 1886.

Europe, though ninety of the latter belong to the genera Adelops and Anophthalmus. A preliminary list of blind non-cavernicolous animals, including deep-sea forms, enumerates less than two hundred species. Under the head of Anatomy of Blind Cave Arthropoda, the following changes in the eyes, optic ganglia, and optic nerves occur in forms living in total darkness: (1) Total atrophy of the optic ganglia and optic nerves, with or without the persistence in part of the pigment (or retina), and the crystalline lens (Cecidotæa, Crangonyx, Adelops, and Pseudotremia). (2) Persistence of the optic lobes and optic nerves, but total atrophy of the rods and cones, retina and facets (*Orconectes pellucidus* and *hamulatus*). (3) Total atrophy of the optic ganglia, optic nerves, and all the optic elements, including rods and cones, retina and facets (Anophthalmus, Scoterpes, and (?) Anthrobia).

It was shown that the blind cave fauna as a whole must have originated from animals living in the upper world at the mouth of the caves or their vicinity. It was shown that there is a more or less exact parallelism between blind cave animals and blind or eyeless deep-sea forms, and the abyssal blind species of the Swiss lakes, as recently proved by the researches of naturalists; the abyssal marine as well as lake species are probably the descendants of immigrants from the well-lighted waters of moderate depths which have become adapted to their abnormal abyssal surroundings. In respect to color as well as loss of visual organs, and often in the elongation of appendages, certain deep-sea forms, at least, appear to resemble many cave forms, the increased tactile sense compensating for the loss of the power of sight. From what is known of the habits of blind or eyeless animals, whether living in caves, in the sea, or in lakes, or in the upper world in the soil or under stones, all are modified in much the same manner, and this is due to similar causes, the most prominent being the absence of light.

Notes on the Distribution of Shells.—From 1880 to the present year I have often collected shells about Eureka Springs, in Carroll County, Arkansas, and in the Kansas City *Review of Science* for 1883 I published a list of forty-two species, not including the Unionidæ, found in that county. Last March—15th to 27th—I made a trip through a number of the counties of Arkansas, commencing with Carroll and extending from there along the western line of the State, Benton and Washington being north of the mountains, Crawford south of them but on the north side of the Arkansas River, and Sebastian on the south side of it. Hot Springs is in Garland County, Hot Springs County south of it, and Jackson County north of Little Rock, on the Iron Mountain Railroad. The following list gives the result of a large amount of searching, though the total time given to it in Carroll County was many times that in any of the other counties.

Mesodon. In Carroll County I have gathered six species of this sub-genus, but not more than two in any of the other counties. Of *albolabris* I got many in Carroll County, most of them of a large size, though on the higher grounds a small variety was found, and also a variety named *alleni* by Professor Wetherby. In Garland County I got a couple of shells of somewhat smaller size than the largest from Carroll County, and darker color. Of *exoleta* I found a small size in Carroll County. For some time after the lip is fully formed the shell is thin, and has no parietal tooth, but it afterwards thickens, and a rather heavy tooth appears. In Washington County I found a single specimen, which was only 19–15 mm. diameter. Of *thyroides*, the same statement in regard to thickness and parietal teeth as in the last is true. This species was originally described as of 22–19½ mm. diameters, but I have it from Indiana 28–23 mm., and from Ohio and Missouri nearly as large. From Carroll County the shells were 22–19 mm., and these have been identified as *bucculentus*, though this is the typical size of *thyroides*. Two shells from Sebastian County were of the same size, and, though apparently mature, they had no parietal tooth. From Jackson County they were larger, being 24–20 mm., and from Benton County were the smallest I have yet seen,—18–15 mm,—one having a parietal tooth, and three others having none; these latter can scarcely be distinguished from *clausus* except by the height. The rare *divestus* was not uncommon in Carroll County; the size, 18–15 mm. From Franklin and Garland Counties they were nearly as large, while from Benton they were only 15–13 mm. I found *elevatus* in Carroll and Jackson Counties, and *clausus* in Carroll only.

Patula perspectiva Say. In abundance in Carroll County; a single one found in Benton County.

Patula alternata Say. In Carroll County it does not differ much from the northern specimens, but in Washington and Garland Counties it is much heavier ribbed, and has darker spots.

Stenotrema leaii Ward. In Carroll, Benton, and Washington Counties.

Stenotrema labrosa Bld. In considerable abundance in Carroll County; also found in Washington, Crawford, and Garland.

Triodopsis inflecta Say. In Carroll County, of light color and 11–10 mm. diameter. Similar but darker colored ones from Benton, Washington, and Franklin Counties. In Garland and Hot Springs Counties each I found one, 12–10 mm. diameters, but looking much larger on account of their height. From Jackson County I have one, 14–11 mm. and elevated, though others from the same place are of the ordinary shape and only 10–9 mm. diameters.

Triodopsis appressa Say. From the bluffs of the White River, in Carroll County; these shells are thin and of a very light horn color, with no indication of tooth on the peristome, even on the

basal side, and with striæ very fine, so that the shell is somewhat glabrous. Largest, 21½–18 mm., and of nearly six whorls. On the bluffs of the Arkansas River, in Crawford County, the same variety is found, the largest observed being 19–16 mm. From Jackson County the shells are much more elevated, of a reddish horn color, with strong, rib-like striæ, and with tooth on basal side of the peristome more pronounced than in the typical shell, and with peristome heavier and more reflected. Size, 19–16½ mm., and five whorls.

Polygyra jacksoni Bland. This rare shell was found in Carroll County in considerable abundance among the gravel and small stones on the hillsides, and rarely under large stones; the size was typical, the largest being about 7 mm. diameter. In Washington County it was about the same size, but on the bluffs of the Arkansas River, in Crawford County, they were much larger, the largest being 8–7 mm. and the smallest 8–7 mm. diameter. They were plenty, and found under large stones. In Sebastian County they were nearly as large.

Polygyra dorfinelliana var. *sampsoni* Wetherby. In Carroll County I have gathered this shell in large numbers, sometimes getting fifteen or twenty under a single stone. They varied in size from 10½–8¾ mm. to 7–6¼ mm. diameter. In Benton and Washington Counties I found a few, and in Crawford County, where the *jacksoni* were of such large size, I got a single one, and it was 8–7 mm. diameter.

Polygyra leporina Gld. In Sebastian County, where I found three specimens of this and of two other species of *Polygyra*.

Bulimulus dealbatus Say. In Carroll and Crawford Counties.

Zonites. Of *arboreus* I got specimens in Carroll, Garland, and Hot Springs Counties; of *indentatus*, in Carroll and Benton Counties; of *friabilis*, in Carroll and Garland Counties; of *demissus*, in Garland County; of *gularis*, in Hot Springs County; and of *ligera*, in Jackson County.

Pupa. I found *fallax*, *armifera*, and *contracta* in Carroll, and the latter in Benton County.

In addition to the foregoing, the following land shells occur in Carroll County: *Patula solitaria* Say; *Triodopsis fallax* Say, variety *minor*; *Strobila labyrinthica* Say; *Macrocyclis concava* Say; *Succinea ovalis* Gld.; *S. verrilli* Bld. (?); *Helicina orbiculata* Say; *Pomatiopsis lapidaria* Say; *Tebenophorus carolinensis* Bosc; and *Limax campestris* Binn.

Of fresh-water shells, I found an abundance of some species, especially in Carroll County. Mr. C. F. Ancey, of France, has described *Physa albofilata* from Eureka Springs. I gathered the same species in Washington County. *Physa heterostropha* and *P. gyrina* were found in Carroll, and the latter in Benton, Washington, and Hot Springs Counties. *Limnæa humilis* was found in Carroll County and *L. columella* in Washington and Hot

Springs Counties; *Planorbis trivolvis* in Carroll and Washington Counties; and *P. bicarinatus* in Carroll and Hot Springs Counties; *Ancylus tardus* in Carroll, Benton, and Washington Counties; *Campolema ponderosa* Say, in Jackson County, *coarctata* Lea, in Carroll and Hot Springs Counties; *Sphærium transversum* and *Pisidium* (?) in Carroll County.

Pleurocera subulare Lea. In White River and King's River, in Carroll County, the latter being much the larger. Two or three species from Ouchita River, Hot Springs County, not yet identified.

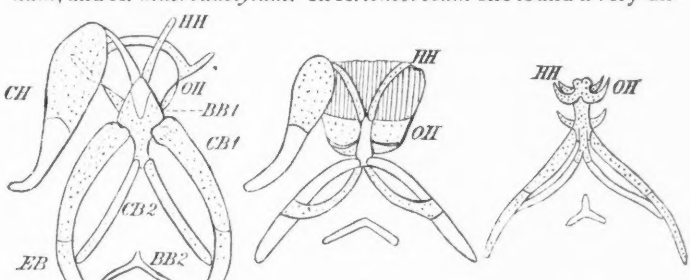
Goniobasis. Specimens of what have been identified as *pallidula* were very plenty in White and King's River, in Carroll County, and what have been identified as *saffordi* in Washington and Hot Springs Counties.

I have some Unionidæ from three counties, but will not attempt now to make a list of what may be found in the State.—*F. A. Sampson, Sedalia, Mo.*

The Characteristics and Relations of the Ribbon-Fishes.—I have been very much interested in the monograph by T. Jeffery Parker "On the Skeleton of Regalecus argenteus" published in *T. Z. S.* (xii. pt. 1). For some years I have mentally set apart the genera *Regalecus* and *Trachypterus* (which I consider to represent distinct families) as a suborder of Teleocephali, and indicated it in 1885, under the name Tæniosomi, in the Standard Natural History (iii. 265), although I could only give external features. Parker's memoir shows that the type is characterized by the basis cranii being simple (there being no basisphenoid), post-temporal not bifurcate, hypercoracoid or scapular foramen marginal, and between the hypercoracoid and hypocoracoid, superior pharyngeals 4, subvertical, none greatly developed, and dorsal rays inarticulate. These characters thus contrast with all other subordinal divisions of the Teleocephali. In addition, the branchihyal apparatus is distinguished by the intercalation of persistent cartilaginous elements, so that Parker recognizes eight pieces in the copula instead of the normal four: "parabranchial" elements (to use Parker's term) are superadded to the first and second epipharyngeals, and the fifth arch has reverted to the original type, and lost its specialization as dentigerous pharyngeal bones. In fact, the segregation of the Trachypteridæ and Regalecidæ from the other fishes into an independent suborder seems well merited. I doubt very much whether the Stylephoridæ belongs anywhere near the group; it is a pity the genus cannot be re-examined. Another point has occurred to me. I am half inclined to think that the Heterosomatous fishes may have branched off from the original stock, or progenitors of the Tæniosomous fishes. I shall investigate the subject when I can get the requisite material.—*Theo. Gill.*

The Hyoid Structure in the Amblystomid Salamanders.—My attention was recently called by my friend Dr. Eleanor Galt to the fact that the figures of the hyoid apparatus of *Amblystoma punctatum* given by Drs. Parker and Wiedersheim are not correct. The latter ("Das Kopfskellet der Urodelen," pl. v. f. 75) represents the hypohyal cartilages as forming the posterior parts of a cartilaginous circle, from which two recurved processes on each side extend, the anterior approaching the ceratohyal, the posterior returning towards the basibranchial. Parker omits the annulus altogether. Now, as Dr. Galt points out, there is a cartilaginous ring which supports the circumference of the tongue in this genus in a manner different from anything known in any other genus of Batrachia. But it is not connected in any way with the hypohyals, but issues from each side of the basibranchial, posterior to them, and supports the tongue above the basibranchial level. It sends out one lateral process on each side (Fig. 1) which does not connect with the ceratohyals.

On examining other species of Amblystomidæ, Dr. Galt found the same character present in *A. talpoideum*, *A. opacum*, *A. tigrinum*, and *A. macrodactylum*. In *A. tenebrosum* she found a very different structure. There is no annulus, but its basal part remains in the form of a plate on each side of the middle line, the external angle of which represents the external process of the ring of *Amblystoma punctatum*. To the straight anterior border of this cartilage is attached a sheet of fibrous tissue, the fibres being distinctly antero-posterior in direction, and forming the basement tissue of the tongue. The cartilage, handle-like in this species, and ring-like in the *A. punctatum*, is not homologous with any of those which have received names, so I propose to call it the otoglossal cartilage.



1 2 3

Fig. 1, *Amblystoma punctatum* $\times$ 2, from below. Fig. 2, *Chondrotus tenebrosus* $\frac{1}{1}$, from below. Fig. 3, *Linguælapsus annulatus*, $\times$ 2, from above. CH, Ceratohyal; HH, hyphohyal; OH, otohyal; BB1, first basi-branchial; BB2, second basi-branchial; CB1, first cerato-branchial; CB2, second cerato-branchial; EB, epibranchial.

These observations of Dr. Galt induced me to examine some of the other species referred to Amblystoma, and I report the fol-

lowing results. The following species have the otoglossal cartilage essentially like that of *A. tenebrosum: A. aterrimum, A. paroticum, A. decorticatum*, and *A. microstomum*. As the type is so entirely different from that of Amblystoma proper, I propose to separate these species under the distinct generic name Chondrotus, with *C. tenebrosus* as the type. Examination of the species recently described as *A. annulatum* and *A. lepturum*,[1] shows that they represent a third genus quite distinct from either of the preceding. Here the otoglossal cartilage (Fig. 3) has somewhat the form of the basal part of that of Chondrotus, but it is entirely free from the basibranchial bone, sliding on it in obedience to the contractions of the pubohyal and genioglossal muscles. This genus I propose to call *Linguælapsus*. I know but two species of it.

According to the figures given by Wiedersheim (*l. c.*), Hynobius and Ranidens do not possess an otoglossal cartilage, agreeing in this respect with the Plethodontidæ. Wiedersheim also shows that the second epibranchial is distinct in these genera, and that the stapes is connected with the quadrate cartilage as in Cryptobranchus. I therefore think that the Hynobiidæ may be retained as distinct from the Amblystomidæ. How many genera it embraces is as yet uncertain.—*E. D. Cope.*

Color of the Eyes as a Sexual Characteristic in Cistudo carolina.—Naturalists interested in our native land-tortoise must often have noticed the bright-red eyes in some individuals. I have seen them so vivid in color as to attract the attention before any other character. In other tortoises of this species the eyes are brown and sometimes gray, so that from bright red through the browns to gray may be considered the extent of color variation.

Some time ago I commenced taking notes as to sex and color of the iris in all the specimens of *Cistudo carolina* met with, and found that the males had red eyes, while those of the opposite sex were for the most part brown or gray. The following were the colors assigned to the eyes, as I observed them at the time of finding the tortoises, and though I have used the word "scarlet" twice, perhaps very bright red would be more correct, though I will leave the characters as originally noted.

Staten Island,	July,	1885.	Full-grown	specimen,	male,	eyes	bright red.
"	"	"	"	"	"	"	scarlet.
"	"	"	"	"	female,	eyes	reddish brown.
"	"	"	"	"	"	"	brown.
"	"	"	One-fourth grown	specimen,	female (?),	eyes	brown.
"	Aug.,	"	Full-grown	specimen,	female,	eyes	reddish brown.
New Jersey,	Sept.,	"	"	"	male,	"	red.
"	July,	1886.	"	"	female,	"	dark gray.
Staten Island,	June,	"	"	"	"	"	"
"	Oct.,	"	"	"	male,	"	scarlet.

I believe these tortoises have a particular fondness for certain locations, for on Staten Island I know of two places where they

[1] Cope, Proc. Amer. Philosoph. Soc., 1886, p. 524.

are particularly numerous, though they occur sparingly over the entire island. These favorite haunts are some twelve miles apart, and differ considerably as to the character of the soil, one being sandy, while the other is a rich wood loam. They present some characters in common, however, for in both the trees are small, with many open, grassy spots, and there are also some permanent wet places. These tortoises require water just as much as common rabbits do, and people who keep them captive in their cellars without giving them any, because they found them on the hill-top, subject them to a needless torture. If water is given them, they will quickly stick their heads into it, and then hold them upright as birds do when drinking.

In autumn they do not always dig under the soil to pass the winter in this locality, but will hibernate in a hollow or any place where a thick mass of leaves has collected. I found one on the 8th of February, 1885, in such a location, with but few leaves for a covering.—*William T. Davis.*

On the Morphogeny of the Carapace of the Testudinata.—Preliminary to a more extended paper on the group Athecæ of the Testudinata, allow me to give the following results, which seem to be of considerable interest:

The Dermatochelydæ (Sphagididæ) are characterized by the development of *independent* superficial dermal bones. In *Dermatochelys coriacea* and the allied extinct forms we find a pavement of small osseous plates extending over the whole shield, jointed to each other by more or less fine sutures. The number of these plates is very much larger than that of the other Testudinata, which never have more than seventy.

In all other Testudinata we find the carapace connected with the internal skeleton. That the carapace of the Dermatochelydæ is homologous to the carapace, without internal skeleton, of the rest of the Testudinata, there is no doubt; that the carapace of the "Thecophora" (Dollo) has developed from the carapace of the "Athecæ" is proved by a specimen of *Eretmochelys imbricata.* In this specimen I find small polygonal plates of the same shape as those of Dermatochelys suturally connected with the third, fourth, fifth, and sixth costal plates.

A form between the Dermatochelydæ and "Thecophora" (Dollo) is represented by the oldest known turtle *Psephoderma alpinum* H. v. Meyer, from the Triassic of the Bavarian mountains, preserved in Munich. In this highly-interesting specimen, never mentioned in monographs on the Testudinata, we have certainly not less than one hundred and ninety-three plates suturally united.[1]—*Dr. G. Baur, Yale College Museum, New Haven, Conn., October* 6, 1886.

[1] It is important to mention that Dermatochelys has the nuchal plate developed besides the mosaic-like carapace. According to Gervais, this plate is covered by

Collections of Humming-Birds.—Hans von Berlepsch has some critical remarks on the humming-bird literature in the "Festschrift of the Cassel Vereins für Naturkunde," 1886. According to this, the largest collection of humming-birds was that of the late John Gould, which is now in the possession of the British Museum. It contained 5378 specimens, representing about 400 species. For second and third places there is a rivalry between Godman and Salvin, of London, on the one hand, and D. G. Elliot, of New Brighton, N. Y. The latter had, in 1878, 380 of the 426 known species, including many of the types of Bourcier, and many of which but a single specimen is known. Salvin and Godman's collection will shortly pass into the possession of the British Museum. Berlepsch himself has the fourth collection in size (about 2000 specimens and 350 species), and close to this is that of George N. Lawrence, of New York, which is especially rich in types.

The Nesting of Collyrio ludovicianus (Baird).—On the 10th of May, 1883, I found, in Williamstown, Mass., a nest of the Loggerhead Shrike, *Collyrio ludovicianus* (Baird). The nest was situated in a sheep-pasture, in a wild-thorn tree, at a distance of seven or eight feet from the ground, and was made from weeds, twigs, and wool, lined with hair and wool. The eggs, six in number, are a greenish-white tint, thickly marked and dotted with light brown and buff-purple spots, which on some of the eggs nearly cover the larger end. A few days later, perhaps a quarter of a mile from the first nest, a second was found, that had evidently been deserted. It contained two eggs similar to those of the former nest, and the construction and materials of the two nests were alike. Mr. H. A. Purdie, hearing of the circumstances, wrote on the 17th of May, 1883, that it was the first known instance of this bird breeding in Massachusetts. So far as I know, nothing was seen of this species in this vicinity until this spring, when I discovered a nest in an elm, perhaps ten feet from the ground, among the branches fringing the huge trunk; the nest was built of materials similar to those composing the nests found in 1883, and the bird was identified. As the last nest was within one hundred and fifty feet of the first, and all three so comparatively near, it is possible that the same pair return from year to year. At any rate, as the first recorded instance of the nesting of this species in Massachusetts, it may be of interest to ornithologists.—*Sanborn Gove Tenney, Williamstown, Mass., Nov.* 27, 1886.

Zoological News.—ECHINODERMS.—Hjalmar Theel, in his report upon the Holothuroidea of the "Challenger" Expedition, not

the carapace. If this statement is correct, we cannot consider the nuchal plate as a part of the dermal skeleton. But the question is, What is the nature of this element? It is possible that it contains the ribs of the last cervical vertebra, with which it is connected.

only describes the new species of the groups Apoda and Pedata, but adds a series of short accounts of all the forms known. Up to 1872 very few forms were known from beyond one hundred, and scarcely any from beyond two hundred fathoms. Now we know of a number met with at five hundred fathoms, and some that are abyssal. Thus *Cucumaria abyssorum* occurs from fifteen hundred to two thousand two hundred and twenty-three fathoms, *Synapta abyssorum* at two thousand three hundred and fifty fathoms, *Pseudostichopus villosus* from thirteen hundred and seventy-five to two thousand two hundred, while *Holothuria thomsoni* has been dredged from depths ranging from eighteen hundred and seventy-five to two thousand nine hundred fathoms. Some species have a wide bathymetrical distribution, individuals residing at depths of from five hundred to seven hundred fathoms presenting no notable differences from others living near the shore.

M. H. Koehler maintains that in the Ophiuridæ the madreporic gland communicates by a canal with the lower or vascular peribuccal ring, much as in the Echini. The internal epithelium of the intestine of the Ophiuridæ is very thick.

M. Gauthier maintains that the plates of the apical region of echinids cannot be depended upon as characters for the delimitation of genera and species. He gives numerous figures of the variations in the apical plates of Hemiaster, from his own observations with the microscope, to prove this. The disposition of these plates, notably that of the madreporic plate, often exhibit the variations relied on to establish species and genera.

VERMES.—*Fecampia erythrocephala* is a parasite in several Decapoda, and has been studied by M. Giard. *Carcinas mænas* is most commonly infested with it when young. It lives in the body cavity, and is often bent into a U form. Some crabs have several parasites. Sometimes it is hidden in the liver. It is 15 to 18 mm. long, with a red head, and white, slightly rose-tinted cylindrical body. When sexually mature it leaves its host, crawls on the rocks, usually on its side, and soon builds a cocoon from threads secreted by the cutaneous glands. The cocoon is most dense upon the inside, becomes brittle by contact with the sea water, and communicates by a narrow opening with the surrounding medium. Within the posterior part of the cocoon the parasite deposits its rose-tinted eggs enveloped in a gelatinous substance. The Fecampia itself has lost much of its bulk, and the snowy tint has disappeared. This transformation takes place at the end of August, at which period the females of *C. mænas* lay their eggs.

TUNICATES.—The "Challenger" Expedition collected one hundred and two species or well-marked varieties of Compound Ascidians. These are described by Professor W. A. Herdman in

vol. xiv. of the Zoological Reports of that cruise. Eighty-eight of the species and ten of the twenty-five genera are new, and two new families are established. The Compound Ascidians, like the simple ones, appear to attain their greatest numerical development in the southern temperate zone. Only twelve species were met with between one hundred and two hundred and fifty fathoms, seven reached to one thousand, and one strange form, *Pharyngodictyon mirabile*, was found at sixteen hundred fathoms. Section of the middle of the post-abdomen of an *Amarœcium* shows three empty cavities, the median one running the whole width of the post-abdomen, while the others, dorsal and ventral, are of irregular section. M. C. Maurice has proved that the median of these three tubes is a dependence of the branchial cavity (epicardium), while the others are prolongations of the pericardiac cavity. The genital organs of Amaræcium are placed in the post-abdomen on the same side of the epicardiac plate and on the dorsal aspect.

FISHES.—M. Yves Delage maintains, contrary to the opinion of Gunther, that the Leptocephala are normal larvæ, capable of transformation. So far from suffering through their distance from the coast, he believes that they finally reach it after having passed through their transformation. The pollack feeds upon these larvæ.

BIRDS.—Professor C. L. Herrick ("Bull. Sci. Lab. Denison Univ.") gives an account of the osteology of the Evening Grosbeak, *Hesperiphona vespertina* Bonap., and compares it with the Pipilo. The Evening Grosbeak seems to have its home in the Saskatchewan region, but visits Minneapolis frequently, and has been seen as far east as Cleveland, O. It is highly gregarious, and the migrating colonies keep up a constant chorus of piercing, but not unmelodious notes. They seem to feed almost entirely on the seeds of the box-elder, maple, poplar, pines, and some other trees. Their note is by no means confined to evening. Another species of the genus, *H. abeillii*, lives in the mountainous parts of Mexico.

The English quarterly journal of Ornithology entitled *The Ibis*, contains in its last issue a valuable article upon the wings of birds, by C. J. Sundeval, with a synopsis of the number of arm-remiges to be found in various species; some notes upon the genus Empidonax, by Mr. R. Ridgway, describing a new species and defining eighteen known species; two papers by Mr. R. B. Sharpe on birds from Fao, in the Persian Gulf, and others from Bushire, on the same gulf; and a list of the birds obtained by Mr. H. Whitely in British Guiana, as well as some shorter papers. The total number of birds on the Guiana list is six hundred and twenty-five, of which thirty-six are migratory or sea-birds. About sixty and one-half per cent. of the remaining

five hundred and eighty-nine forms occur in the Amazons valley, twenty-seven and one-half per cent. in Venezuela, thirty-three per cent. in Columbia, thirty-six and one-half per cent. in Ecuador, forty-seven and one-half per cent. in Peru, thirty-three per cent. in Southeast and Central Brazil. The West Indies have but four per cent. of the birds of Guiana, or no more than are possessed by the Argentine Republic.

MAMMALIA.—The Central American Mammalia, dealt with by the late Mr. E. R. Alston, consist of one hundred and eighty-one species; Cetacea are not included in the work. Fifty-two of these species are bats, sixty rodents, and eleven quadrumana. The last are Neotropical forms that have penetrated northward. One only, *Ateles vellerosus*, has spread into Mexico to twenty-three degrees N. lat. The cats are southern or wide-spread, the dogs all northern. Seven out of the eight known Procyonidæ are found here, the exception being *Nasua rufa* of Brazil. Four species of Cariacus, the big-horn sheep, the prong-buck, two peccaries and two tapirs are the sole Ungulata. Among edentates three kinds of anteater, an armadillo, three sloths, and seven opossums extend beyond Panama.

EMBRYOLOGY.[1]

The Formation of the Eggs and Development of Rotifers.[2]—G. Tessin has made a very important contribution to the life-history of the wheel-animalcules, which he has traced in *Brachionus urceolaris*, *Euchlanis dilatata*, *Salpina mucronata*, and *Rotifer vulgaris*, having succeeded in obtaining satisfactory sections of the embryos in a number of stages.

The large simple sac opening into the cloaca, which has hitherto been regarded as the ovarium, is, according to Tessin, not an ovary at all, but the eggs are developed on the outside of this organ from a heap of cells lying on its right side and near its anterior end. As a rule, the number of nuclei in the ovarian mass is constant, eight nuclei being the usual number; only in the fixed Tubicolariæ, Philodinæ, and Pterodina could a larger or smaller number of ovarian nuclei be made out.

In the process of maturation the nucleus of the egg gradually passes to the periphery, where it breaks up; but before it does so a nuclear spindle is developed. This process Tessin regards as an indication that polar cells are extruded, although he did not actually succeed in finding them.

None of the accounts hitherto given of the manner of segmentation are correct, according to this author. The egg is first divided transversely into two unequal cells, the cleavage plane being also slightly oblique, and the larger cell anterior, the smaller

[1] Edited by Dr. JOHN A. RYDER, Philadelphia.

[2] Ueber Eibildung und Entwickelung der Rotatorien, Zeitschr. f. Wiss. Zoologie, xliv., 1886, pp. 272–302, pls. xix., xx.

posterior. The larger cell is next divided transversely, a smaller mass being segmented from it behind. Then follows the division in twain of the smaller of the two primary cells. The four resulting blastomeres then assume a symmetrical disposition with respect to the future median axis. The three posterior smaller cells mark the future dorsal aspect of the body; the larger cell marks the position of the future anterior end.

From this point onward the segmentation is essentially meroblastic, the smaller posterior and dorsal cells segmenting and investing the larger anterior cell from behind forwards and laterally by a process of epiboly. Meanwhile, the posterior acuminate end of the large anterior cell becomes segmented into a number of cells, which take a share in the formation of the ectoderm, together with the smaller dorsal cells already spoken of. While the formation of the entoderm is thus accomplished, the most anterior row of the dorsal group are destined, as shown by later events, to form the mesoderm. By this time the larger anterior cell has been further subdivided, and its component blastomeres to the number of five, which form the rudiment of the endoderm, are included by the growth forward and downward of the advancing ectoderm. The mesodermic cells, which at first formed a transverse row at the edge of the dorsal group of ectodermic cells, are pushed farther forward and downward, and are finally thrust inward between the ectoderm and mesoderm along the anterior, or what may finally be regarded as the dorsal, border of the blastopore or prostoma. Since the mesoderm is developed in almost all bilateral forms from the entoderm, the development of it from the ectoderm in Rotifers, as here described, is probably characteristic and of taxonomic importance. A solid gastrula (sterro-gastrula) is thus formed, and the prostoma (blastopore) assumes an anterior ventral position and marks the place where the permanent mouth is developed. The genesis of the mesoderm in Rotifers is contrasted with the mode of its origin in Astacus, according to Reichenbach, at the anterior margin of the blastopore. It is thought probable that the musculature and sexual organs are developed from the mesoderm.

The blastopore assumes a quadrate form, and the ectoderm bounding it is divided into four well-marked lobes,—a right and left, an anterior and a posterior lobe. From the invaginated portion of the ectoderm, lying within the blastopore, the œsophagus (which lies in front of the mastax) and the wheel-organ or trochal disk are developed. The posterior lobe of the ectoderm becomes divided off posteriorly from the blastopore by a transverse fissure or constriction, leaving the posterior lobe free, which thus becomes the rudiment of the young Rotifer's tail. The anterior and lateral lobes, bounding the blastopore, finally blend and become differentiated into the cephalic extremity of the animal.

The metamorphosis of the entodermal mass of cells already

mentioned is very remarkable. The entodermic cells form a solid globular mass, filling up for a time the hinder three-fifths of the still nearly solid gastrula. This mass is next subdivided into a sharply circumscribed anterior portion, in which the mastax is developed, and a posterior portion, from which the rest of the alimentary tract is formed.

As a result of these elaborate and apparently very successful studies, Tessin concludes that the Rotifers are not affiliated very closely with the higher Annelids, but, on the one hand, with the Turbellaria, and on the other with the Crustacea; with the former on account of the well-marked lobes around the blastopore and the mode of origin of the mesoderm, and with the latter on account of the mode of invagination of the mesoderm at the anterior margin of the blastopore, the development of a post-abdomen with a forked tip, the position and fate of the blastopore, and the somewhat similar position of the anus in some aberrant forms of Crustacea (*Cetochilus*). In summing up he concludes that the Rotifers form a special group, which should be placed somewhere between lower worms and Crustacea.

The Gestation of Armadilloes.—A very remarkable mode of uterine gestation has very recently been described by Von Jhering[1] in a Brazilian armadillo (*Praopus hybridus*). Though the notice published by this observer is a very brief one, and evidently preliminary, the conclusions arrived at are novel and of great interest, as indicating that it is possible that a mode of reproduction may occur in a mammal simulating parthenogenesis. The natives informed him that the female armadillo always produced litters of young, the individual members of which were invariably of only one sex. This observation he had been able to fully confirm and to announce that the fœtuses of a single litter are enveloped in a common chorion,[2] and, while the placenta of each fœtus is discoidal, the individual placentæ of the litter are so disposed as to form a compound zonary placenta. These two sets of facts led Von Jhering to conclude that all the young produced at one litter by the armadillo are the product of the fertilization of a single egg, which produced a number of embryos by the fission or subdivision of that ovum subsequent to impregnation.

New observations were made upon the development of the claws of the young armadilloes, which Von Jhering found were developed in a singular manner, obviously recapitulating some of the characteristics of the extinct forms.

The reviewer gives a synopsis of Von Jhering's arrangement of the types or principal modes of reproduction. Two great subdivisions are recognized:

[1] Biolog. Centralbl., vi. pp. 532–539 (No. 17, 1886).

[2] It is significant in this connection that when human twins are enveloped in a common chorion they are always of the same sex.

1. Hologeny. From the fertilized egg but one individual takes its rise, with or without metamorphosis. Hypogenesis (Haeckel).

2. Merogeny. From the fertilized egg two or more individuals are developed, which,—

A. Revert directly to the form and manner of reproduction of the parent. Temnogenesis.

B. Develop into individuals which become different, or a series of generations, varying in their mode of development (alternation of generations, metagenesis).

a. Calycogenesis (Salpa, Medusæ).

b. Paidogenesis (Cecidomyia).

c. Heterogenesis, in which either both generations are sexually reproduced, or one or several are reproduced parthenogenetically.

The peculiar type of reproduction called "temnogenesis" by Von Jhering, and characteristic of *Praopus hybridus*, leads to the somewhat paradoxical conclusion that the mother may become the grandmother of her own child, in virtue of the segmentation of the ovule into a number of distinct germs, which lead to the development of as many distinct individuals of the same sex. The same thing apparently occurs when in the human subject twins are invested by a common chorion. The subject, however, needs further investigation, especially since the researches of Dareste, Fol, Kleinenberg, and especially of Rauber, have so greatly extended the views of Lereboullet in respect to the mode of origin of double monsters among vertebrates or pleurogastric types. That the production of double monsters occurs among hypogastric types in essentially the same way as in the vertebrates seems to be pretty conclusively established by Mr. Ryder's observations upon double monstrosities among lobster embryos.

ANTHROPOLOGY.

Chinese Jade in America.—In the "Proceedings of the American Antiquarian Society," vol. iv. p. 62, Mr. Frederick W. Putnam makes a report of jade objects which have a double interest. Twelve specimens are reported from Nicaragua and Costa Rica, ten of which were ornaments made by cutting celts into halves, quarters, or thirds, a portion of the cutting edge of the celt remaining on each piece. The method of sawing the objects is indicated. The first query, therefore, is, For what reason should a celt of such hard material be cut up and perforated? Let us suppose that the original blade belonged to the outfit or accoutrement of a celebrated warrior, hunter, or artist. The pieces of that blade would become powerful medicine or influential fetishes and highly prized.

Greater astonishment is excited when we read the report of Mr. O. W. Huntington upon the nature and source of the material in these ornaments. It is as follows: "The specimens

which you left with me are unquestionably Chinese Jade, having all the characters of that mineral, although the largest specimen from Costa Rica is rather unusual in its color, and would not be taken for jadeite at sight."

No. 33,395, Costa Rica, H. = 7. Sp. gr. on 166 grms., 3.281. A small fragment before the blow-pipe fused readily below 3 to a glassy bead.

No. 33,391, Costa Rica, H. a little under 7. Sp. gr. on 54½ grms., 3.341. Fused quietly below 3 to transparent glass, not acted on by acid.

No. 32,794, Costa Rica, H. a little under 7. Sp. gr. on 13 grms., 3.326. Fused quietly below 3 to a transparent glass, not acted on by acid.

The day has gone by for hasty conclusions, and Professor Putnam would be one of the last to jump at one. The NATURALIST will shortly give account of evidences of connection of Costa Rica with Polynesia by means of a witness in another kingdom of nature. It will now be in order to collate during the next ten years the evidence for and against contact between the Orient and the western shores of America which will speak for itself.

Ornaments on Pottery.—It is thought by some that ornamental patterns on pottery are handed down by savages from one generation to another. This is not true of our Indian, who, after making a pot, ornaments it with improvised designs. He has no pattern-books to guide him.

Indians of New Mexico accustomed to pottery-making have, since their contact with whites, given attention to more elaborate ornamentation; just as those of Mexico meet a demand and find their way into public and private collections. The most noticeable change in technique is the use of animal and human forms, which, though not unknown on older pieces, are rare.

Toy forms of pottery and those animal and human designs which met the readiest sale have been most improved by a kind of natural selection.

The thirst for antiquities has also stimulated the native artists to imitate them. In the city of Mexico an Italian made a good living for three years making stone sculptures in imitation of antiquities. The writer saw some of his works, but they were easily detected. The children all had European faces, and the delicate parts of the body were too well worked out.

Near the city of Mexico live a settlement of Indians who have the credit of manufacturing clever imitations of ancient pottery.

The noble custom of exciting in children the love of the beautiful through toys and dolls was not neglected by the ancient Mexicans. Even at our day a striking example is the manufacture of toys in great profusion at Guadalajara, which are sold not only throughout the republic but outside.

They are taken on the backs of men and animals, packed in baskets and crates. These toys are very truthful representations of the manners and customs of the people. For the rude apparatus employed they are truly remarkable. The most interesting fact about this ware is the way in which the artist holds on to ancient forms, and in the decoration yields himself absolutely to the whims and demands of the market. He even borrows from the Spaniard the art of silvering and gilding.

This almost total hiding of the old thing which they are unwilling to give up, with paint and forms to which their old art was a stranger, is also seen in their gourd vessels.

The pitchers from Toluca, once simple unnozzled vessels, are lost in the large spouts, altered handles, polished surface, elaborate decoration, glazing, and stamping.

Still one may visit regions in Mexico where the old art still survives. The Pames, near the Valle del Maiz, and the Huastecas, the Indians of Sierra Nola and of Savanito, away from the influence of innovations, make their pottery as of old, simple in form and decoration.—*Edward Palmer*.

Head-flattening.—Dr. R. W. Shufeldt, U.S.A., contributes to the *Journal of Anatomy and Physiology* a paper on the skull of a Navajo child. The most interesting feature of this skull is the marked parieto-occipital flattening. The plane is somewhat oblique, and there is not only a flattening but a gentle depression over the entire area involved. The bones flexed are the two parietals from a little in front of the obelion, and almost the whole of the supra-squamous portion of the occipital. Dr. Shufeldt has not seen a Navajo skull lacking this feature. Navajo women carry their children about strapped on a stiff cradle-board, with only a small, narrow pad beneath the occiput. However, it is only the infants of a few months of age that have their heads bound down closely to the backboard of their portable cradles. Just as soon as they are able to support their heads and have acquired sufficient strength to control the movements of this part of the body, they are at once allowed considerable more latitude in this particular. Indeed, in the case of children who range from six months, or at the most eight months, of age, and upwards, I have never observed that the Navajo mothers strap their children's heads at all. If the strapping of the head during these first few months of infant life is sufficient to produce this lasting deformity, then the problem is surely solved once for all.

Love and Anthropology.—Professor Paolo Mantegazza has published in Milan two volumes on love among the different races of men, which have been reviewed in several foreign magazines. Following his example, Dr. D. G. Brinton has laid the tender passion upon the dissecting-table, and given to the world the result of his work in a paper read before the American Philo-

sophical Society on the 5th November, based upon one of Carl Abel's "Linguistic Essays" (London, 1882).

The key-note of Dr. Brinton's study is in his second paragraph, in which he says, "I shall give more particular attention to the history and derivation of terms of affection as furnishing illustrations of the origin and growth of those altruistic sentiments which are revealed in their strongest expression in the emotions of friendship and love.

"Upon these sentiments are based those acts which unite man to man in amicable fellowship, which bind parent to child and child to parent, which find expression in loyalty and patriotism; which, exhibited between the sexes, direct the greater part of the activity of each individual life, mould the form of social relations, and control the perpetuation of the species; and which have suggested to the purest and clearest intellects both the most exalted intellectual condition of man, and the most sublime definition of divinity."

In the Old World and in the New, Dr. Brinton finds the principal words expressing love in one of two ruling ideas, the one intimating similarity between those loving, the other a wish or desire. The former conveys the notion that the feeling is mutual, the latter that it is stronger on one side than on the other.

A third class of words of later growth combines the two sentiments into the loftiest terms of affection.

The existence of these forms of expression is traced through the Algonquin, Nahuatl, Maya, Qquichua, and Tupi-Guarani stocks with the following general results:

1. The original expression of love as revealed in the languages of those people was as follows:

1. Inarticulate cries of emotion (Cree, Maya, Qquichua).

2. Assertions of sameness or similarity (Cree, Nahuatl, Tupi, Arawack).

3. Assertions of conjunction or union (Cree, Nahuatl, Maya).

4. Assertions of a wish, desire, or longing (Cree, Cakchiquil, Qquichua, Tupi).

Loochoo, sometimes written Liuchiu, and called by the Japanese Riukiu, is the chief island of a group lying in the North Pacific Ocean between the 24th and 29th parallels of latitude, and forming a chain extending from Formosa to the southernmost extremity of Japan. The Chinese accounts state that the island of Loochoo was discovered by an exploring expedition sent out by the Emperor Yang Kwang, of the Sui dynasty (A.D. 608), which brought back to China one of the inhabitants. It was subsequently visited more than once by the Chinese, and early in the fourteenth century one of the emperors of the Ming dynasty sent some thirty Chinese families to Loochoo to civilize the natives, and teach them the arts and customs of China. Each

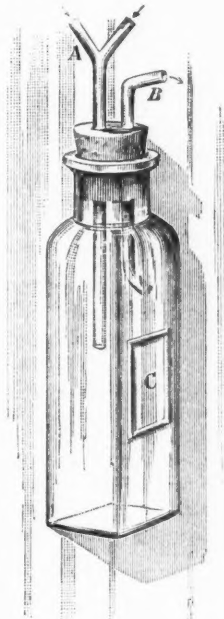
king of Loochoo, upon his accession to the throne, sent special envoys to announce the fact to the emperor, and to ask that commissioners be sent to confer investiture upon the new king. This was always acceded to, and the reports of some of the commissioners have been published in China and Japan, which are exceedingly well written and illustrated. The king of Loochoo always used as his seal of state one conferred upon him by the Chinese emperor. He also sent envoys at stated times to bear tribute and congratulations to the emperor, who generously allowed them to bring with them a certain number of the sons of the Loochooan nobles to be educated, at the emperor's expense, in the Kwo tsi Kien, or National College, at Peking. This state of things continued until after the change in the Japanese government, in 1868, when it was put to an end by the Japanese. The Japanese first became acquainted with the Loochooans A.D. 1451, when certain Loochooans brought a present of one thousand strings of cash (or Chinese copper coins) to the ruling Shogun, and from this time the Loochooans traded frequently to Hiogo and Kagoshima. Their relations to Japan were always of a most friendly character, and their vessels came very frequently bearing presents. But, A.D. 1609, Iyehisa, prince of Satsuma, fitted out an expedition to Loochoo, captured the king, and brought him prisoner to Kagoshima. He was released at the end of three years, although the Japanese could not succeed in inducing him to abjure his allegiance to the emperor of China, yet compelling him to pay an annual tribute to the prince of Satsuma, as the Japanese histories say, and forbidding him to inform the Chinese of the fact. From this time until 1868, the Loochooans continued to pay tribute both to China and Japan. When Commodore Perry wished to insert some provisions relating to Loochoo in his treaty with the Shogun ("tycoon"), the latter was unable to accede to Perry's wish, as the Shogun had no jurisdiction, Loochoo being considered by the Japanese as a dependency of the prince of Satsuma, and Commodore Perry (and after him the Hollanders) concluded a separate convention with the king or regent of Loochoo. After the surrender, in 1871, by the Japanese feudal princes to the Mikado of their territorial powers and possessions, the Imperial government, claiming Loochoo as a former dependency of the Prince of Satsuma, commenced to introduce more and more Japanese laws and regulations into Loochoo; and finally, in 1879, notwithstanding the earnest remonstrances of the Loochooan king's envoys, who appealed for aid to the Chinese minister in Tokio, as well as to our own minister, the Hon. John A. Bingham, the Japanese dethroned the king of Loochoo, and brought him with his family to Tokio, where he now is receiving a pension from the Japanese government, who have supplanted the native Loochooan officers and laws by Japanese officials and the Japanese code,

and have prohibited the Loochooans from paying tribute to China or from holding commercial intercourse with that country. The course pursued by Japan was deeply resented by China, and war between the two countries seemed for a while highly probable. Prince Kung and the viceroy Li Hung Chang requested General Grant to act as mediator, but the Japanese were unwilling to submit the case to arbitration, and the question still remains unsettled, and prevents the existence of anything like cordiality between the governments of China and Japan.—*D. Bethune McCartee, M.D.*

MICROSCOPY.[1]

Orienting Objects in Paraffine.—In the *Zool. Anz.*, No. 199, Selenka has described a method of keeping paraffine melted while the contained small objects are being arranged under the microscope in any desired position, and then of rapidly cooling the paraffine without disturbing the position of the objects.

Finding it difficult to make tubes such as he describes, which should be of such shape as to admit of removing the hardened paraffine readily, and at the same time with depressions of sufficient size for any but very minute objects, I have made use of the following simple device, which, though more clumsy than the tube of Selenka, can be used for objects 1 mm. long and much larger, while giving a block of paraffine of very regular shape and with rectangular sides.



A common flat medicine-bottle is fitted with a cork through which two tubes pass, or if the mouth is small one tube may be fastened into a hole drilled into the bottle. One of these tubes (*A*) is connected with hot and cold water; the other (*B*) is a discharge-pipe for the water entering the bottle by (*A*), and raising or lowering its temperature as warm or cold water is allowed to flow in. On the smooth flat side of the bottle four pieces of glass rods or strips are cemented fast so as to enclose a rectangular space (*C*) which forms a receptacle for the melted paraffine. As long as the warm water circulates through the bottle the paraffine remains fluid, and objects in it may be arranged under the microscope by light from above or below, and

[1] Edited by Dr. C. O. Whitman, Milwaukee.

can be oriented with reference to the sides of the paraffine-receptacle or with reference to lines drawn upon the surface of the bottle.

When the cold water is allowed to enter in place of the warm, the paraffine congeals rapidly and may be easily removed as one piece. The discharge-pipe should open near the upper surface of the bottle, to draw off any air which may accumulate there.—*E. A. Andrews.*

Orientation of Small Objects for Section-Cutting.—It is frequently a very difficult matter to properly orient small objects, especially spherical eggs, so that sections may pass through any desired plane. In my work on the embryology of the common shrimp I have found the following process very convenient. Impregnation with paraffine is accomplished in the usual way, and then the eggs (in numbers) in melted paraffine are placed in a shallow watch-crystal. They immediately sink to the bottom, and then the whole is allowed to cool. The crystal, glass upwards, is now placed on the stage of the microscope and the eggs examined under a lens. In this way one can readily see exactly how any egg lies, and then with a knife it may be cut out with the surrounding paraffine, and in such a way that it can readily be fastened to the block in any desired position. After all which have dropped in a suitable position are thus cut out, the paraffine is again melted, and after stirring the eggs the cutting out is continued as before.—*J. S. Kingsley.*

PSYCHOLOGY.

The Perception of Space by Disparate Senses.—The following is an abstract of an interesting paper by Mr. Joseph Jastrow on the nature of space conceptions, contributed to *Mind*, vol. xi. p. 539. It records the result of experiments made on different persons at the Psychophysical Laboratory of the Johns Hopkins University, Baltimore:

In order to approach the problem by experimental methods it will be necessary to define accurately such terms as sight, touch, motion. The following classification, though provisional and imperfect, will perhaps be found convenient. We can obtain the notion of extension:

I. By the stimulation of a definite portion of a sensitive surface.

(1) Of the retina (where the distance of the stimulating object must be inferred);

(2) Of the skin,

(*a*) By the application of a pair of points, leaving the intermediate skin unstimulated, or (*a*) stimulating it by the application of a straight edge;

(*b*) By the motion of a point along the skin (see *Mind*, 40 pp. 557 ff.); [(*a*) and (*b*) may be contrasted as simultaneous and successive.]

II. By the perception of distance between two movable parts of the body, *e.g.* between thumb and forefinger;

III. By the free motion of a limb, *e.g.*, the arm.

The operations to be known as reproducing judgments by the eye, the hand, and the arm are respectively,—judging lengths by fixing the eyes upon them without motion of the eyeball, a form I; judging distances between thumb and forefinger, a form of II; and judging distances by guiding a pencil over them with a free arm movement, a form of III.

The problem was to compare the judgments of linear extension made by these three senses, and to determine their relative accuracy. The method consisted in presenting a definite length to one of these senses of the subject, who was then required to adjust a second length equal to the first by the use of the same or of another sense. The judgments were confined to lengths between 5 and 120 mm. The lower limit is set by the inconvenience of seeing, drawing, and measuring such small lines; the upper by the greatest "span" between thumb and forefinger, as well as by the longest line distinctly visible without motion of the eyeball. More direct methods of testing the relative fitness of these senses and of their memory for absolute lengths were also employed. In several of the operations the two sides of the body were involved, and it became necessary to study the effect of this circumstance.

RESULTS.

In judging that a length perceived only by the eye is equal to another length perceived either by the eye, hand, or arm, there will be an error. The problem consists in tracing the nature and extent of this error.

I. When the receiving and expressing senses are the same.

(1) If the eye is both receiving and expressing sense, small lengths will be underestimated, and large lengths exaggerated, the point at which no error is made being at about 38 mm.;

(2) If the hand is both receiving and expressing sense, small lengths will be exaggerated, and large lengths underestimated, the indifference point being at about 50 mm.;

(3) If the arm is both receiving and expressing sense, all lengths (within the limits of the experiments) will be exaggerated.

The conclusions above discussed may be summarized thus:

When the same acts as the receiving and the expressing sense, the error is small (and the process easy). In operations involving the use of both sides of the body, an interchange of the function of the two sides reverses the results; when one hand

alone is used in successive judgments, no such reversal takes place. The preferred hand in span-sensations is the right; the preferred arm in motion, the left. The error of the eye is less than that of the hand; the error of the hand slightly less than that of the arm.

II. When the receiving and expressing senses are different.

(1) If the eye is the expressing sense, and (*a*) the hand the receiving sense,

All lengths are greatly underestimated, the error decreasing as the length increases.

If the eye is the expressing sense, and (*b*) the arm the receiving sense,

All lengths are greatly underestimated, the error decreasing as the length increases. By combining the two conclusions we see that,—

If the eye is the expressing sense, all lengths are greatly underestimated, the error decreasing as the length increases.

(2) If the hand is the expressing sense, and (*a*) the eye the receiving sense,

All lengths are greatly exaggerated, the error decreasing as the length increases.

If the hand is the expressing sense, and (*b*) the arm the receiving sense,

All lengths are greatly exaggerated, the error decreasing as the length increases.

If the hand is the expressing sense, all lengths are greatly exaggerated, the error decreasing as the length increases.

(3) If the arm is the expressing sense, and (*a*) the eye the receiving sense,

All lengths are greatly exaggerated, the error decreasing as the length increases.

If the arm is the expressing sense, and (*b*) the hand the receiving sense,

All lengths are greatly underestimated, the error decreasing as the length increases.

A. The error decreases as the length (to be reproduced) increases.

This means that (within the limits of the lengths experimented upon) a larger length is reproduced more accurately than a smaller one.

B. If reproducing one sense by another results in an exaggeration (or underestimation), then reproducing the second sense by the first will result in an underestimation (or exaggeration) to about the same extent.

C. A third rather peculiar law remains to be noticed. The processes involved in the above-described experiments can be represented thus: A length presented to the receiving sense makes a certain impression on my brain-centre; the problem,

then, is to reproduce the objective stimulation, which shall give me an equivalent sensation. The two operations being simultaneous, the sensations can be compared and the judgments corrected until they agree. When the receiving and expressing senses are the same, the comparison is between homogeneous sensations, involving one brain-centre; the operation is easy and the error small. When the expressing sense differs from the receiving sense, heterogeneous sensations must be compared, involving two brain-centres,—a difficult operation with a large error. The large error seems to be due to a looseness of association between heterogeneous space-centres; it is a path of high resistance. Why this error is in the direction in which it is, and not in the opposite direction, depends on some fundamental relation of the senses involved, still to be discovered. For the present the fact that the same objective spacial stimulation has a different value for the several space-senses is to be emphasized. Our conclusions, then, are (1) that the memory for absolute measurements is not quite accurate, the order of accuracy being sight, span, motion; (2) that the operation probably consists in matching the reproduction with the homogeneous mental recollection; (3) that the visual inch is too short, the span- and motion-inch too long. These conclusions evidently favor the point of view of law C.

D. Finally, a comparison of the error in reproducing by the same and by a different sense leads to the very important conclusion that the former operation is an accurate and easy one, the latter an inaccurate and difficult one. The difficulty manifests itself as a feeling of discomforting uncertainty and lack of confidence in one's judgments, and a great susceptibility of fatigue. The connection between senses seems to be a loose one.

SCIENTIFIC NEWS.

— Engelmann, of Leipzig, announces a continuation of the well-known Bibliotheca Zoologica of Carus and Engelmann, bringing the work down to 1880. The former work contained a catalogue of the literature of zoology from 1846 to 1860, and was itself a continuation of Agassiz's Bibliographia Zoologiæ et Geologiæ, which contained the works previous to the earlier date. The establishment of the *Zoologischer Anzeiger* in 1878 furnished a regular record for zoological literature, and hence this continuation of the Bibliotheca fills in the gap between the *Anzeiger* and the Bibliotheca of Carus and Engelmann, and thus places in the hands of zoologists a complete list of works on zoology. This continuation will be edited by Dr. Taschenberg, of Halle,

and will make about twelve parts of three hundred and twenty pages each, and is issued at a price of seven marks per part.

— Gustav Haller, a student of the mites, died May 1, 1886, at Berne.

— George Busk, a well-known English zoologist, whose writings on the Polyzoa and Hydrozoa are standards, died in London, August 10, 1886, in his seventy-eighth year.

— Students of the Coleoptera will miss Maurice Girard, a French entomologist, who died in August, 1886, aged sixty-four; and even more Baron Edgar von Harold, who, with Gemminger, compiled a most valuable catalogue of the Coleoptera of the world. He died in Munich, August 1, 1886.

— Dr. A. C. Oudemans, of Utrecht, has been made director of the Zoological Gardens at the Hague. His place as conservator of the Zoological Museum of Utrecht has been filled by C. H. van Herwerden.

— Karl Plötz, a student of the Lepidoptera, died at Greifswald, August 12, 1886, aged seventy-three.

— H. C. Weinkauf, a conchologist, died at Kreuznach, August 14, 1886.

— Professor A. Hyatt's "Larval Theory of the Origin of Tissues" has been translated into Pelletan's *Journal de Micrographie.*

— Dr. Alois von Alth, the mineralogist and palæontologist of Cracow, died November 5, 1886. He was professor of mineralogy in the University of Cracow.

— Professor L. Dieulafait, professor of geology at Marseilles, died recently. Dr. Depéret, of Lyons, has received a call to fill the chair thus left vacant.

— Mr. Edward J. Miers, the eminent student of Crustacea, has been forced by continued ill health to resign his position as assistant in the British Museum.

— To the French desire for conquest and colonization is to be attributed the death of the celebrated physiologist Paul Bert. He was born at Auxerre, France, October 17, 1833. In 1867 he became a "docent" at Bordeaux, and in 1875 he received the grand prize of the French Academy, amounting to four thousand dollars. In 1878 he became president of the Biological Society of France, and in 1882 was made a member of the Academy of Sciences. He held various political offices, and exhibited such administrative ability that he was appointed governor of the newly-conquered province of Tonkin. He died at Hanoi, November 11, 1886.

— A new *Centralblatt für Bacteriologie und Parasitenkunde* is announced from the publishing house of Gustav Fischer, Jena.

It is to be issued in weekly numbers at an annual cost of twenty-eight marks, and is to concern itself with the phenomena of vegetable and animal parasitism in the widest sense. Dr. Oscar Uhlworm, Cassel, is the editor, Professor Leuckart and Dr. Loeffler being associated with him. Professor R. Ramsay Wright, Toronto, has undertaken to furnish a report to the new journal of papers published on this continent referring to animal parasites, and will be obliged to authors for extras of such papers.

— At the last meeting of the Regents of the Smithsonian Institution a number of changes were introduced into its organization. Professor Samuel Langley, of Alleghany, Pa., was elected assistant secretary, and Mr. G. Brown Goode was made second assistant secretary. These appointments open up a long future of prosperity to the institution, other things being equal.

— It is not generally known that it is to the late General John A. Logan that the United States owes its Geological Survey. He introduced and had passed the first bill for this object, and Dr. F. V. Hayden was sent, under its provisions, to Nebraska, the field of its first operations.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Indiana Academy of Science.—The second annual meeting of the Indiana Academy of Science was held in the court-house at Indianapolis, December 29 and 30, 1886. The sessions were presided over by the president, Professor D. S. Jordan. Twenty-five new members were elected after their applications had passed through the hands of the nominating committee. The Academy was called to order at ten o'clock A.M., December 29, and opened with prayer by Rev. A. R. Benton. J. C. Branner, S. Coulter, and P. S. Baker were appointed a committee to nominate officers for the next year. J. P. D. John, J. M. Coulter, and O. P. Hay were appointed a committee to consider applications for membership. Following the business of the morning the papers here enumerated were taken up. "Origin of the Indiana Flora," by J. M. Coulter; "The Mildews of Indiana," by J. N. Rose; "The Chlorophyll Bands of Spirogyra," by S. Coulter; "Outline of a Course in Science Study based on Evolution," by Lillie J. Martin; "The Moss Leaf," by C. R. Barnes; "Additions to the Flora of Jefferson County, Ind.," by George C. Hubbard; "Our Blind Mice," by E. R. Quick; "Notes on the House-Building Habits of the Muskrat," by Amos W. Butler; "A Curious Habit of the Red-headed Woodpecker," by O. P. Hay; "Notes on Indiana Ornithology," by A. W. Butler; "The Work of the A. O. U. Committee on Bird Migration," by B. W. Ever-

mann; "The Higher Classification of the Amphibia," by O. P. Hay; "Some Reptiles and Amphibians that appear to be Rare in Indiana," by O. P. Hay; "Some Reptiles and Amphibians that are to be looked for in Indiana," by O. P. Hay; "Notes on the Winter Habits of Amblystoma tigrinum and A. microstoma," by O. P. Hay. The following papers were on the programme for the afternoon: "Notes on Birds observed in Carroll County, Ind.," by B. W. Evermann; "Review of Diplodus and Lagodon," by C. H. Eigenmann and Elizabeth G. Hughes; "Review of the American Chætodontidæ," by C. H. Eigenmann and Jennie Horning; "The Fishes of the Wabash and some of its Tributaries," by O. P. Jenkins; "The Relation of Latitude to the Number of Vertebræ in Fishes," by D. S. Jordan; "Elagatis pinnulatis at the East End of Long Island Sound," by S. E. Meek; "Ospradium in Crepidula," by H. L. Osborn; "Notes on the Acrididæ of Bloomington, Ind., with Descriptions of Four New Species," by C. H. Bollman; "A Remarkable Case of Longevity in the Longicorn Beetle, Eburia quadrigeminata Say," by Jerome McNeill; "Some Biological Studies of Lixus macer Say, and L. concavus L.," by F. M. Webster; "Descriptions of Four New Species of Myriapods from the United States," by Jerome McNeil; "New North American Myriapods, chiefly from Bloomington, Ind.," by C. H. Bollman; "The Teaching of Entomology in the High Schools," by Jerome McNeill; "The Geodetic Survey in Indiana," by J. L. Campbell; "Recent Progress in Seismology," by T. C. Mendenhall; "An Indiana Earthquake," by J. C. Branner. At night President Jordan delivered his address on "The Dispersion of Fresh-Water Fishes."

Thursday the following papers were presented: "On the Oxidation of Para-xylene Sulphamide by Potassium Ferricyanide," by W. A. Noyes and Charles Walker; "The Scientific Study of Psychic Phenomena," by H. W. Wiley; "Causes of the Variation of Sucrose in Sorghum," by H. W. Wiley; "Preliminary Location of a Parting in the Subcarboniferous in Monroe County, Ind.," by J. H. Means and J. C. Branner; "The Limit of the Drift in Kentucky and Indiana," by J. C. Branner; "The Deep Well at Bloomington, Ind.," by J. C. Branner; "Town Geology —What it is and What it Might be," by V. C. Alderson; "On the Thysanura," by R. F. Hight; "Natural Gas and Petroleum," by A. J. Phinney; "The Geology of Vigo County, Ind.," by J. T. Scovell; "The Niagara River," by J. T. Scovell; "The Zone of Minor Planets," by Daniel Kirkwood; "The Bearing of the Lebanon Beds on Evolution," by D. W. Dennis; "The Surface Geology of the Wabash-Erie Divide," by C. R. Dyer; "Zoantharia rugosa," by A. J. Phinney; "The Physical Geography of Decatur County, Ind., during the Niagara Period," by W. P. Shannon; "The Estimation of the Carbonic Acid in the Air," by T. C. Van Nuys and B. F. Adams; "The New Alkaloid, Co-

caine," by P. S. Baker; "The Nation—the Subject Matter of Political Science," by A. B. Woodford; "The Manner of the Deposit of the Glacial Drift, and the Formation of Lakes," by O. P. Hay.

The following officers were elected for the next year: President, John M. Coulter; Vice-Presidents, J. P. D. John, J. C. Branner, T. C. Mendenhall; Secretary, Amos W. Butler; Treasurer, O. P. Jenkins.

The Academy will hold its spring meeting May 19 and 20, at a place to be selected by the Executive Board. C. R. Barnes and B. W. Evermann were selected to arrange the programmes for the meetings of 1887.

Boston Society of Natural History, 1886.—December 1.—Mr. S. R. Bartlett reviewed Ranvier's anatomical studies of some Mammalian Salivary Glands, and Professor W. T. Sedgwick spoke of the Contractile Vacuoles of Paramœcium, etc. Mr. W. L. Harris exhibited some rare (living) Amblystomas, and an aberrant form of the Newt.

December 15.—Dr. Edward G. Gardiner reviewed recent researches on a Third (rudimentary) Eye in Lizards, and Professor W. M. Davis discussed the Mechanical Origin of the Triassic Monoclinal in the Connecticut Valley. The Section of Entomology met on Wednesday evening, December 22.

New York Academy of Sciences.—Monday evening, December 6, 1886.—Mr. Seth E. Meek presented a paper entitled "The Fishes of Cayuga Lake."

December 13.—A series of a hundred lantern views, illustrative of the paper lately read before the Academy upon the subject of Earthquakes, were exhibited by Dr. J. S. Newberry.

Biological Society of Washington.—Saturday evening, October 16, 1886.—The following communications were read: Mr. F. H. Knowlton, "Fascination in Ranunculus and Rudbeckia;" Mr. J. B. Smith, "A Novel Form of Insect Invasion;" Mr. F. W. True, "A Revision of the Genus Lagenorhynchus."

November 27.—The following communications were made: Mr. William H. Seaman, "Notes on Marsilia quadrifolia (illustrated)." Mr. P. L. Jouy, "Observations made during a Journey through Corea." Mr. Lester F. Ward, "Autumnal Hues of the Columbian Flora." Dr. C. Hart Merriam, "Contributions to North American Mammalogy. Description of a New Species of Bat."

December 11.—The following communications were made: Dr. Theobald Smith, "Parasitic Bacteria and their Relation to Saprophytes." Mr. F. A. Lucas, "On the Osteology of the Spotted Tinamou, Nothura maculosa." Mr. C. D .Walcott, "Tracks found on Strata of Upper Cambrian (Potsdam) Age." Dr. Frank

Baker, "The Foramen of Magendie." Dr. C. Hart Merriam, "Contributions to North American Mammalogy. Description of a New Sub-species of Pocket-Gopher."

Appalachian Mountain Club.—Special meeting, Thursday evening, December 16, 1886.—A semi-social meeting was held from 7.30 to 10.30. Photographs were on the tables for examination. During the evening a paper entitled "A Trip to Norway and the North Cape" was presented by Miss Marion Talbot. Lantern views of Norwegian scenery were shown. Rev. John Worcester showed lantern views of scenery on the Presidential Range, north of Washington.